R.A.G. ENTERPRISES
NEW AND USED ELECTRONIC TEST EQUIPMENT SALES AND SERVICE

4400 Series

DIGITAL MULTIMETER

Accessory Modules

210 and 220

DANA LABORATORIES, INC.
2401 CAMPUS DRIVE
IRVINE, CALIFORNIA 92664

DANA®

TELEPHONE (714) 833-1234
TELETYPE 910-595-1136
TELEX 678-341

Publication

980291

4400 Series *

DIGITAL MULTIMETER

Accessory Modules

210 and 220

* For Model 4432, see Section 7

April 1968

Revised December 1971

DANA LABORATORIES, INC.
2401 CAMPUS DRIVE
IRVINE, CALIFORNIA 92664

DANA®

TELEPHONE (714) 833-1234
TELETYPE 910-595-1136
TELEX 678-341

Warranty

Within one year of purchase, Dana Laboratories will repair or replace, at our option, your instrument if in any way it is defective in material or workmanship. All parts and labor charges will be paid by Dana Laboratories. Just return the instrument to your nearest authorized Dana Service Center freight prepaid. We will return it to you freight prepaid.

DANA

Congratulations on your choice of a Dana instrument. . . . . .

Now that you are using the instrument, Dana would like to help you to take full advantage of its capabilities.

To do this, Dana issues addendum sheets, revision sheets, and application data sheets to be included in your instruction manual. To see that these reach you, please fill in and return the reply card below. In the event that you have received a preliminary instruction manual, the return of the card will ensure your receiving a final manual as soon as it is available.

Dana Laboratories manufactures a complete line of digital voltmeters, data amplifiers, frequency counters, and frequency synthesizers. Catalogs are available; to get your copy, simply check the appropriate box on the reply card.

To keep my instruction manual updated, please send revision pages, application data, or other supplementary information to:

Name _____

Company _____

Address _____

City _____ State _____ Zip _____

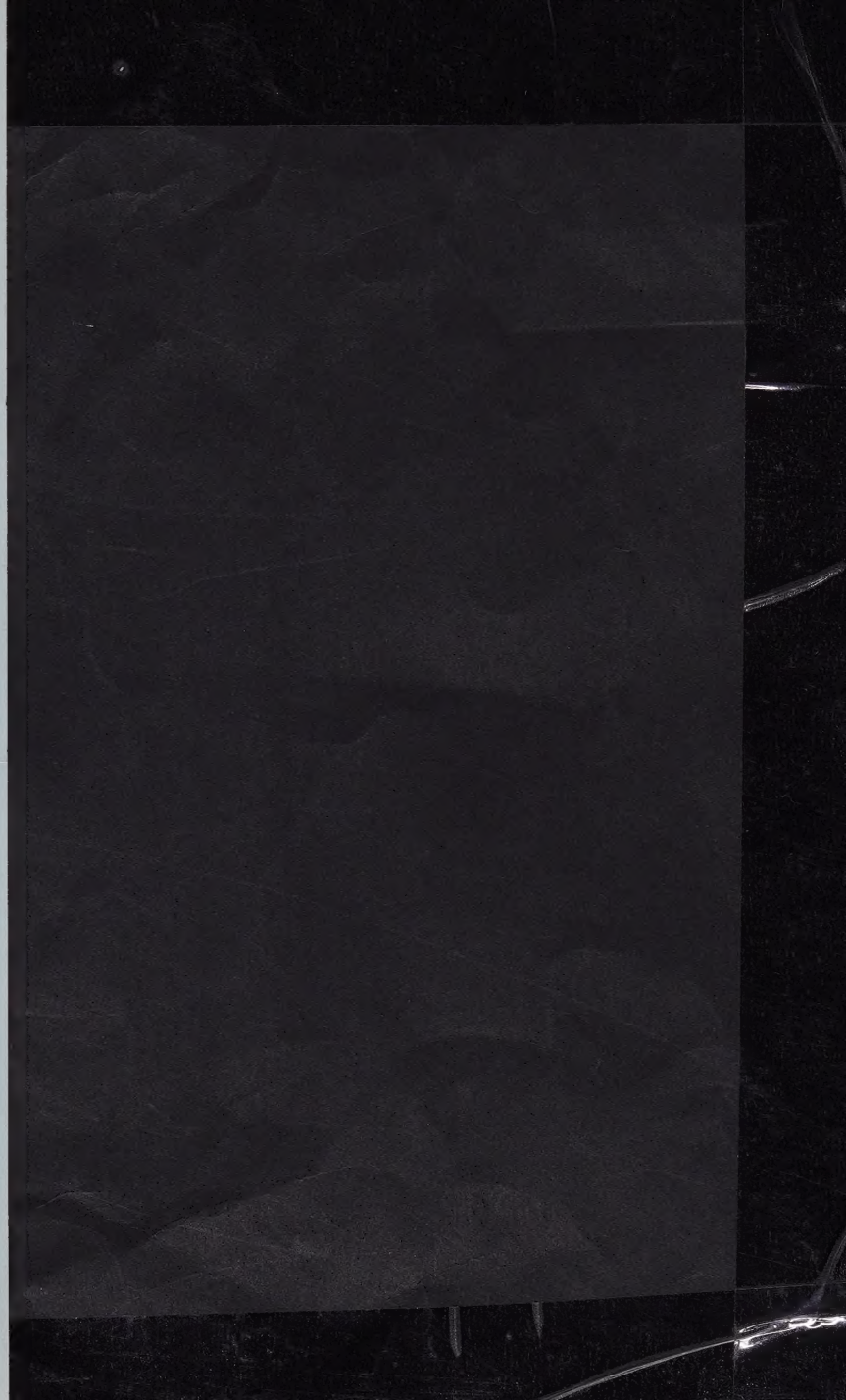
Dep't _____ Section _____

My Dana instrument is a _____ , Model _____

Serial No. _____ I received it on (date) _____

Also, please send information on:

☐ *DVMs*
☐ *Data Amplifiers*
☐ *Frequency Counters*
☐ *Frequency Synthesizers*
☐ *Field Service Bulletins*



FIRST CLASS
PERMIT NO. 413
NEWPORT BEACH,
CALIFORNIA

BUSINESS REPLY MAIL

No Postage Stamp Necessary If Mailed In The United States

Postage Will Be Paid By

Dana Laboratories, Inc.
2401 Campus Drive
Irvine, California 92664

Attn: Marketing Department

TABLE OF CONTENTS

Section	Title	Page
1	INTRODUCTION.	1-1
1.1	Introduction.	1-1
1.3	Mechanical Description	1-1
1.8	Electrical Description	1-1
1.12	Specifications	1-2
2	INSTALLATION.	2-1
2.1	Unpacking and Inspection	2-1
2.5	Power Connections	2-1
2.7	Input Connections	2-1
2.9	Initial Checkout Procedures.	2-1
2.12	Zero Check	2-2
2.13	Polarity Gain Check.	2-2
2.14	Range Check	2-2
2.15	AC Check (220 Accessory Module Only).	2-2
3	OPERATION	3-1
3.1	Controls	3-1
3.12	Operation	3-1
4	THEORY OF OPERATION	4-1
4.1	Introduction.	4-1
4.4	Accessory Module	4-1
4.6	Isolator.	4-1
4.9	AC Converter (Module 220 only).	4-4
4.13	Range Control	4-4
4.20	Active Filter.	4-4
4.22	Digitizing and Display Module.	4-6
4.24	Auto Polarity	4-6
4.26	Ramp	4-6
4.28	Internal Reference	4-7
4.30	Null Detector	4-7
4.33	Binary Counter.	4-8
4.35	Control Logic	4-8
4.42	Blanking Circuit	4-12
4.44	Range Logic.	4-12
4.48	Overload	4-14
4.51	Polarity Sense	4-14
4.53	Clock	4-15
4.56	BCD to Decimal Decoding	4-15
4.59	Power Supply	4-15
4.68	Integrated Circuit Elements.	4-20
4.71	J-K Flip-Flop Operating Modes	4-20
4.74	Schematic Identification of Logic Devices	4-20

TABLE OF CONTENTS (Continued)

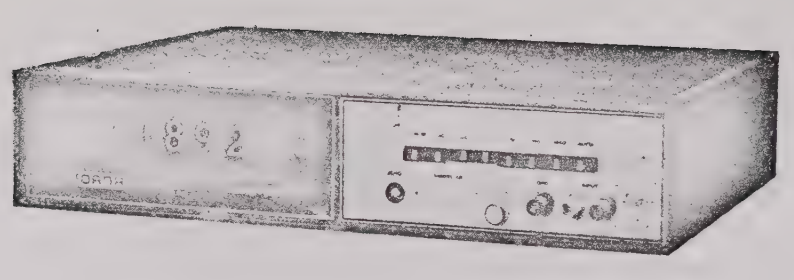
Section	Title	Page
5	MAINTENANCE	5-1
5.1	Calibration	5-1
5.4	Equipment	5-1
5.7	Tools	5-1
5.8	Other	5-1
5.9	Preparation	5-3
5.10	Ramp Generator Zero Adjustment (Display Module)	5-3
5.11	Null Detector Zero Adjustment (Display Module)	5-3
5.12	Internal Reference Adjustment (Display Module).	5-3
5.13	DC Isolator Zero Adjustment	5-4
5.14	DMM Polarity Adjustment (Display Module)	5-4
5.15	Positive and Negative Gain Adjustment (Display Module)	5-4
5.16	Voltage Divider Adjustment	5-6
5.17	Calibrate Test Adjustment (Display Module)	5-6
5.18	AC Voltage Divider Adjustment (Accessory Module 220)	5-6
5.19	Troubleshooting	5-6
5.23	Repair	5-26
6	DRAWINGS.	6-1
6.1	Drawings	6-1
7	BCD OUTPUT OPTION (Model 4432)	7-1
7.0	General.	7-1
7.5	Operation.	7-1
7.7	External Command	7-2
7.9	Delays	7-2
7.11	Print Command Output	7-2
7.13	BCD Coding.	7-2
7.15	Pin Assignments	7-3
7.18	Dana 4432 Output/Printer Interface	7-4

LIST OF ILLUSTRATIONS

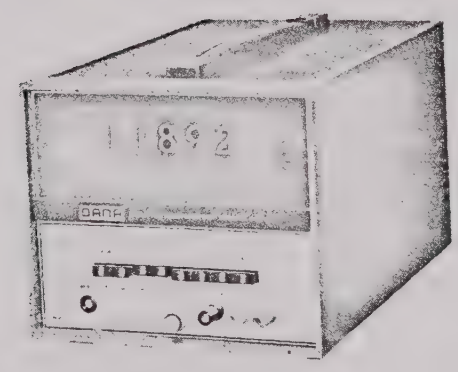
Figure	Title	Page
1.1	Series 4400 Digital Multimeters	vii
1.2	Block Diagram — 4400 Series DMM	1-2
4.1	Simplified Diagram - Accessory Module	4-2
4.2	Range Control	4-3
4.3	Active Filter	4-4
4.4	Block Diagram - Digitizing and Display Module	4-5
4.5	Auto Polarity Circuit	4-6
4.6	Ramp	4-7
4.7	Internal Reference	4-8
4.8	Null Detector	4-9
4.9	Binary Counter	4-9
4.10	Rate Control	4-10
4.11	Read Control Circuitry	4-11
4.12	Ramp Control	4-11
4.13	Counter Control	4-12
4.14	Overload and Range Logic	4-13
4.15	Polarity Sense	4-14
4.16	Clock	4-15
4.17	Counter Logic	4-16
4.18	3.6-Volt Supply	4-17
4.19	High Voltage Supply	4-17
4.20	28/18-Volt Supply	4-18
4.21	Flip-Flop Operating Modes	4-19
4.22	Interconnected Nor Gates	4-20
4.23	Component Identification	4-20
4.24	Function Designator	4-20
4.25	Logic Symbols	4-21
4.26	J-K Flip-Flop	4-22
4.27	Dual J-K Flip-Flop	4-23
4.28	Decoder Display	4-24
4.29	Dual Buffer	4-25
4.30	Quad Two-Input Nor Gate	4-26
4.31	MC724 Used as a Crystal Oscillator	4-27
5.1	Display (Readout) Module	5-2
5.2	Locations, AC Converter (Bottom View)	5-5
5.3	Test Setup - Reference Calibration	5-5
5.4	Figure 5.4.	5-8
5.5	Figure 5.5.	5-9
5.6	Figure 5.6.	5-10
5.7	Figure 5.7.	5-11
5.8	Figure 5.8.	5-12
5.9	Figure 5.9.	5-13
5.10	Figure 5.10	5-14

LIST OF ILLUSTRATIONS (Continued)

Figure	Title	Page
5.11	Figure 5.11	5-15
5.12	Figure 5.12	5-16
5.13	Figure 5.13	5-17
5.14	Figure 5.14	5-17
5.15	Figure 5.15	5-18
5.16	Figure 5.16	5-19
5.17	Figure 5.17	5-20
5.18	Figure 5.18	5-21
5.19	Figure 5.19	5-22
5.20	Figure 5.20	5-23
5.21	Timing Diagram	5-24
5.22	Primary Circuit	5-25
5.23	Ranging Circuit	5-33
5.24	Counter and Display.	5-33
5.25	Logic	5-34
5.26	Logic Control	5-34
5.27	Auto Polarity	5-35
5.28	Ramp	5-35
5.29	Internal Ramp	5-36
5.30	Null Detector	5-36
7.1	Typical Output Circuit.	7-1
7.2	External Command	7-2
7.3	Print Command	7-2
7.4	Read Command	7-4
7.5	Read Command Switch	7-4
7.6	4432/CMC 410A Interconnecting Cable	7-5
7.7	BCD Output Interconnection Diagram	7-7



Model 4430/220



Model 4470/220

Figure 1.1. *Series 4400 Digital Multimeters*

SECTION 1

INTRODUCTION

1.1 INTRODUCTION

1.2. This manual describes the Dana Series 4400 Digital Multimeters (DMM). The basic models are the 4430 and the 4470 which differ only in their mechanical packaging. Model 4430 is a thin-line instrument (3-1/2 inches high) designed for standard rack mounting while Model 4470 is primarily a bench type instrument (see figure 1.1). Descriptions in this manual apply to all models unless otherwise indicated.

1.3 MECHANICAL DESCRIPTION

1.4. Each instrument consists of two modules. The Digitizing and Display Module, comprising the left-hand portion of Model 4430 and the upper half of Model 4470, contains the actual measurement circuits and is the same in all instruments in the series. The Accessory Module, comprising the right-hand side of Model 4430 and the lower half of Model 4470, contains signal conditioning circuits that provide a ten-volt full-scale (plus overrange) analog voltage for measurement by the Digitizing and Display Module.

1.5. This manual covers two Accessory Modules: Models 210 and 220. Accessory Module 210 provides measurement of DC voltages. Module 220 has the additional capability of AC measurements. The combination of modules produce four DMM models designated as 4430-210, 4430-220, 4470-210, and 4470-220.

1.6. The power supply is common to the Accessory and Digitizing modules and is located at the rear of the instrument. The Digitizing and Display circuits are located on a single printed circuit board called the Isolator while the Module 220 has an Isolator board and an AC Converter board. Circuits consist of integrated circuits except for critical analog circuitry where discrete components are used.

1.7. The output is displayed on a four-digit visual display with a fifth overrange digit that extends full-scale of each range by 20% (9999 to 11999). Automatic ranging is performed by internal circuits that determine the optimum range and switch to that range automatically.

1.8 ELECTRICAL DESCRIPTION

1.9. A block diagram of the DMM is shown in figure 1.2. For DC measurements, the input is applied to a voltage divider at the input that divides the input voltage by 1 or by 100 depending on the range selected. The scaled input is applied, through an active three-pole filter, to the Isolator amplifier which delivers 10 volts full-scale (12 volts, with overrange) to the Digitizing and Display module. The gain of the amplifier is either 1 or 10, depending on the range.

1.10. For AC measurements, the AC Converter scales the input and rectifies it. The Converter output is then applied to the voltage divider (set to divide by one), through the filter, and to the Isolator amplifier, set to a gain of ten.

1.11. The Digitizing and Display module measures the analog voltage from the Accessory Module by

the high-accuracy ramp technique. The amplitude of the input signal is measured by comparing it to an internally referenced integrated step function or ramp. The DMM readout displays the position of a counter that measures the time required for the ramp voltage to reach the level of the input signal. The value displayed is equal to the voltage level of the input. Readings are taken four times a second with the OFF-ON-HOLD switch in the ON position. The HOLD position permits the instrument to remain at the last reading indefinitely. Reading accuracy of the DMM is maintained through the use of a crystal-controlled counter and a highly stable, zener-regulated, internal reference voltage.

1.12 SPECIFICATIONS

1.13. Specifications are listed in table 1.1.

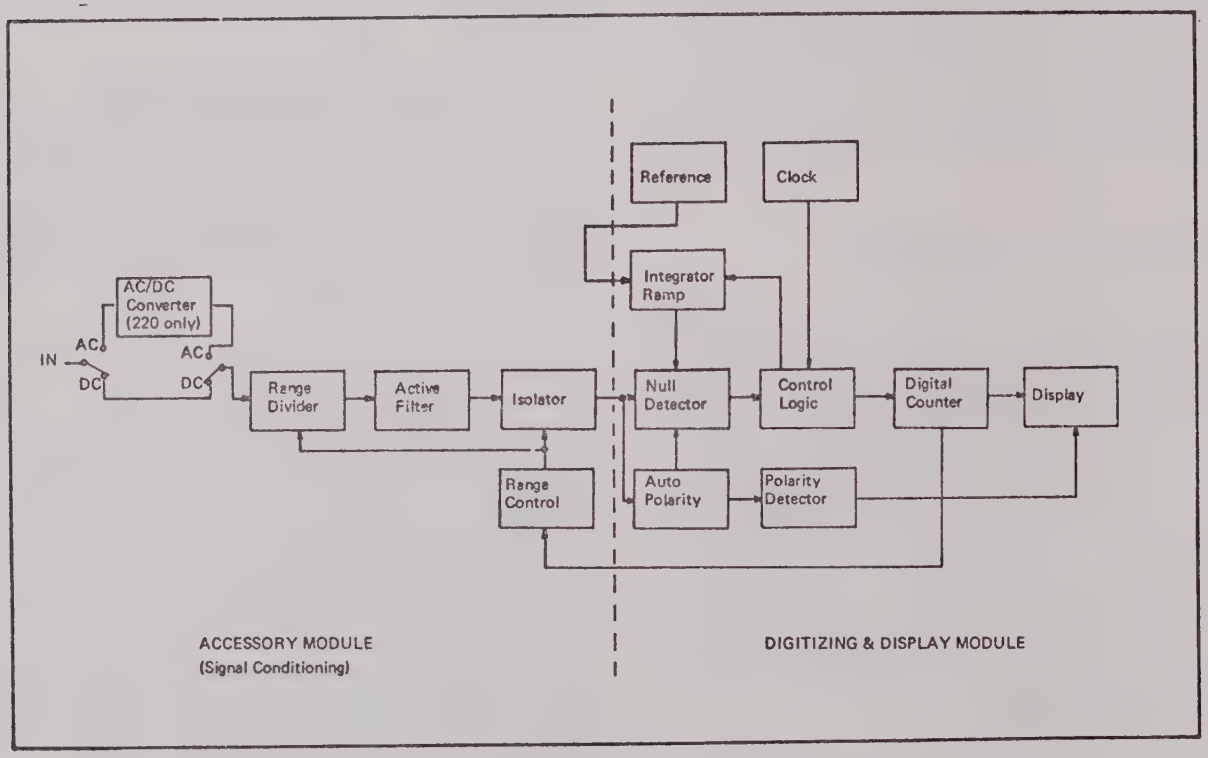


Figure 1.2. Block Diagram - 4400 Series DMM

Table 1.1
Specifications

DC VOLTS:

Ranges (auto ranging & auto polarity): ±1.2, 12, 120, 1200 V (1000 V MAX)

Absolute Accuracy: ±0.01% of reading ±0.01% of F.S.

Resolution: 100µV

Noise Rejection (superimposed): 60 dB, 59 Hz and up; increasing 18 dB/octave to 80 dB maximum.

Common Mode Rejection: At dc, 100 dB (1 Kilohm in either lead)
At 60 Hz, 100 dB on .1, 1, and 10 volt ranges
80 dB on 100 volt range
60 dB on 1000 volt range

Input Resistance: 1000 megohms: 10 V range
100 megohms: 1 V range
10 megohms: 100, 1000 V ranges

AC VOLTS:
(For 220 Accessory Module only)

Ranges (auto ranging): 1.2, 12, 120, 1200 Vrms

Frequency Range: 50 Hz to 100 kHz

Absolute Accuracy: ±0.25% of reading ±0.05% of F.S.: 50 Hz to 100 Hz
±0.1% of reading ±0.02% of F.S.: 100 Hz to 5 kHz
±0.5% of reading ±0.05% of F.S.: 5 kHz to 20 kHz
±2.0% of reading ±0.1% of F.S.: 20 kHz to 100 kHz

Resolution: 100µV

Maximum Voltage Rating: 500 Vrms, 50 Hz to 10 kHz, decreasing to 100 V at 100 kHz

Common Mode Rejection: 60 dB, 61 Hz and below, with up to 1 kilohm in either lead

Input Impedance: 1 volt range: 2.0 Megohm ± 1%
10 volt range: 1.05 Megohm ± 1%
100 volt range: 1.0 Megohm ± 1%
1000 volt range: 1.0 Megohm ± 1%

Shunt Capacitance: Less than 100 pF

GENERAL:

Settling Time: 0.5 second, dc mode; 2 seconds ac mode

Maximum Common Mode Voltage: 250 volts

Measurement Rate: 4 per second

Warm Up Time: 1/2 hour to full accuracy

Operating Temperature Range: +15°C to +40°C

Power Requirement: 25 watts, 105 to 125 V (export 210 to 250 V), 50 to 400 Hz

Rack-mounting Hardware: Half-rack flanges (for Model 4470), Part No. 402660
Full-rack flanges (for Model 4430), Part No. 402588

Input Connector: Front standard; parallel rear optional (add -1 to model number)

Weight: 15 pounds (approx) net, 30 pounds (approx) shipping

Dimensions: Model 4430, 17 x 3½ x 14 inches; Model 4470, 8½ x 7 x 14 inches

CAUTION

TO AVOID DAMAGING THE INTEGRATED CIRCUITS, DO NOT REMOVE OR INSTALL MODULES WHILE POWER IS TURNED ON.

SPECIAL NOTE

The shipping carton and its internal support structure have been scientifically designed for maximum protection of the instrument. Dana recommends saving the carton and contents for use in future reshipping of the instrument. Alternate packing methods, such as plastic foam blocks and loose packing material, may prove to be insufficient for maximum protection and result in damage during shipment.

If reshipping is required and the original carton is not available, special packing instructions can be obtained from Dana Labs' Product Service Department.

SECTION 2

INSTALLATION

2.1 UNPACKING AND INSPECTION

2.2. The 4400 series DMM is sandwiched between two forms of plastic foam and packed in a double-walled cardboard carton for shipment. The plastic forms hold the DMM securely in the carton and absorb any reasonable external shock normally encountered in transit. Prior to unpacking, examine the exterior of the shipping carton for any signs of damage. Carefully remove the DMM from the carton and inspect the exterior of the instrument for any signs of damage. If damage is found, notify the carrier immediately.

2.3. The 4400 series DMM, as shipped, is designed for bench-top operation. A standup bracket is provided under the case to aid in reading the visual display. The Model 4430 instrument can be adapted for rack installation with two flange mounting holes located in each of the two side panels. The rack-mounting kit (Dana 402588) is attached to the instrument by removing and discarding the four set screws occupying the mounting screw holes and securing the two rack mounting flanges to the side panels of the instrument with the four screws contained in the rack mounting kit.

2.4. The Model 4470 can be ordered from the factory as a half-rack instrument or the standard instrument can be returned to the factory for modification to accommodate the half-rack mounting hardware.

2.5 POWER CONNECTIONS

2.6. A standard eight-foot, three-wire, power cable is supplied with the instrument. This cord connects to a three-pin power connector at the rear of the unit.

2.7 INPUT CONNECTIONS

2.8. Signal input binding posts are located on the front of the accessory module. Connections to these terminals are made with standard "banana" plugs. Make connections as described under "Manual Operation", paragraph 3.2. Instruments designated by a "dash 1" (−1) following the model number are equipped with a duplicate set of input binding posts on the rear panel of the instrument.

2.9 INITIAL CHECKOUT PROCEDURES

2.10. The following procedure is performed to verify that no damage has occurred during shipment and that the instrument is operative. Slight deviations in readings during the following tests may be corrected by making simple adjustments. For instructions refer to Section 5, "Calibration". Any major discrepancies should be reported to the carrier and to Dana Laboratories immediately.

2.11. Prior to performing the checkout procedure, it may be advisable to refer to the operating instructions beginning with paragraph 3.2. Allow one-half hour for instrument to warm up before proceeding.

2.12 ZERO CHECK

(a) Select DC and 1 range.

(b) Short input leads. Visual readout should display 0.0000.

(c) If necessary, adjust ZERO control on front panel to obtain this reading.

2.13 POLARITY GAIN CHECK

(a) Select DC and 10 range.

(b) Apply a known voltage of approximately -10 volts to the input. Visual readout should display value of input voltage (within specified tolerance) and proper polarity.

2.14 RANGE CHECK

(a) Select DC and 100 range.

(b) Connect input to a source of +100 volts DC.

(c) Visual readout should display input value (within specified tolerance) and proper polarity.

(d) Vary input voltage and polarity; check for proper readout.

(e) Repeat the above four steps on 1000-volt range.

(f) Select Auto range and repeat the above checks.

2.15 AC CHECK (220 Accessory Module only)

(a) Select AC.

(b) Connect signal generator to input.

(c) Set generator to 50 Hz.

(d) Check for proper readout (within specified tolerance) with each of the following input voltages applied: 9 volts, 90 volts, and 125 volts.

NOTE

If the DMM has been stored for a prolonged period (5 or 6 months) without use, it is recommended that it be operated with a variable transformer, such as a Variac, at one-half line voltage for about two hours before gradually applying full power. This is done to "reform" the electrolytic capacitors in the amplifier and reduce the chance of capacitor failure.

SECTION 3
OPERATION

3.1 CONTROLS

3.2 DIGITIZING AND DISPLAY MODULE

3.3. OFF-ON-HOLD SWITCH. This dual-purpose switch applies power to the instrument and allows the selection of HOLD.

(a) OFF - all power is removed from the instrument.

(b) ON - the instrument is operating and taking readings at four per second.

(c) HOLD - "freezes" the last reading of the instrument until it is switched back to the ON position.

3.4. CALIBRATE ADJUSTMENT. This is a flat-blade screwdriver-adjusted potentiometer used in conjunction with the accessory module to calibrate this DMM. Instructions for this operation are described in paragraph 3.7.

3.5. ACCESSORY MODULE

3.6. All controls on the Model 210 and Model 220 Modules, with the exception of the screwdriver-adjusted ZERO control, are pushbutton switches, located on the front panel.

3.7. CALIBRATE SWITCH. This is a momentary switch that causes a test reading to appear in the DMM display readout as long as the switch is depressed. The DMM is calibrated by adjusting the calibration potentiometer on the DMM for a readout of -1.0000 (decimal shown for 1V range).

3.8. AC SELECT (220 only). This switch selects the measurement of AC voltages from 50 Hz to 100 kHz.

3.9. DC SELECT. This switch selects DC measurements from 100μV to 1000 volts. On the 220 module, the DC select switch is interlocked with the AC select switch to prevent the selection of both modes at the same time.

3.10. RANGE CONTROL. The range control consists of five interlocking pushbutton switches: 1, 10, 100, 1000 and AUTO.

(a) Manual ranges. Ranges are selected by depressing the appropriate switch. The switches are interlocked so that as one range switch is depressed, the previously selected range switch is returned to open position.

(b) Auto range. This mode allows the DVM to select the range that provides the highest accuracy for the signal being measured. This switch is interlocked with the four range switches.

3.11. ZERO ADJUST. To zero the DMM, short the two input leads together, select DC and auto-range. Adjust the ZERO potentiometer for a DMM readout display of 00000.

3.12 OPERATION

3.13. GENERAL. The instrument has been designed for the simplest possible level of operation. Once the instrument has been connected to the power line and to the signal source in accordance with the instructions, the operator can make all the required measurements by setting the front

panel controls to the indicated positions.

> CAUTION
>
> Voltage applied between ground and the low-input terminal must not exceed 250 volts.

3.14. DC MEASUREMENTS. Attach the high side of the signal source to the red signal input terminal, the low side to the white signal input terminal. Normally, the ground terminal (which is at the DMM Chassis Ground) is jumpered to the white signal input terminal by the supplied shorting bar. To operate the DMM on a floating basis, detach the ground terminal from the white input terminal.

3.15. AC MEASUREMENTS (220 only). Attach the high side of the signal source to the red signal input terminal, the low side to the white signal input terminal. Normally, the ground terminal (which is at the DMM Chassis Ground) is jumpered to the white signal input terminal.

SECTION 4

THEORY OF OPERATION

4.1 INTRODUCTION

4.2. Theory of operation of the 4400 Series DMM is described in two parts. First, the Accessory (signal conditioning) Module is described; then the Digitizing and Display Module. The purpose of the Accessory Module is to supply a 10-volt analog voltage for measurement in the Digitizing and Display Module.

4.3. Diagrams used in this section are intended to supplement the complete schematics included in Section 6. All logic circuits are defined at the end of this section.

4.4 ACCESSORY MODULE

4.5. Accessory Module 210 or 220 provides a ten-volt full scale (12 volts with overrange) analog signal for measurement by the Digitizing and Display Module. The two models are similar except that the 220 Module has the addition of an AC/DC Converter circuit board allowing it to measure AC voltages. The other circuits, in both models, are mounted on a single Isolator Board. This board contains the isolator amplifier, range control circuits, and an active filter. The Isolator in Model 210 is called the DC Isolator and in Model 220 is called the AC-DC Isolator. The two are slightly different because of the additional switching required for AC measurements. The following descriptions apply to both models unless otherwise indicated.

4.6 ISOLATOR (Figure 4.1)

4.7. The Isolator is a floating input potentiometric amplifier capable of operating at very low signal levels. Its output is a 10-volt full scale analog voltage (12 volts, in overrange) that is applied to the Digitizing module for measurement. The amplifier operates at a gain of one or a gain of ten, depending on the range. The gain is switched by relay K2 that inserts a resistor divider into the feedback circuit when energized.

4.8. The input to the Isolator is applied through a ranging network that divides the input by 1 or 100, depending on the state of relay K1. This relay and relay K2 are operated by the range control signals $\overline{R1}$ and $\overline{R2}$. Operation of the relays is such that the voltage divider at the input and Isolator gain combine to provide 10 volts full scale in all measurement modes (table 4.1).

Table 4.1

Code	Range	Full Scale Isolator Input*	Isolator Gain
$\overline{R1}$ $\overline{R2}$	1	1V	10
R1 $\overline{R2}$	10	10V	1
$\overline{R1}$ R2	100	1V	10
R1 R2	1000	10V	1
*Plus Overrange			

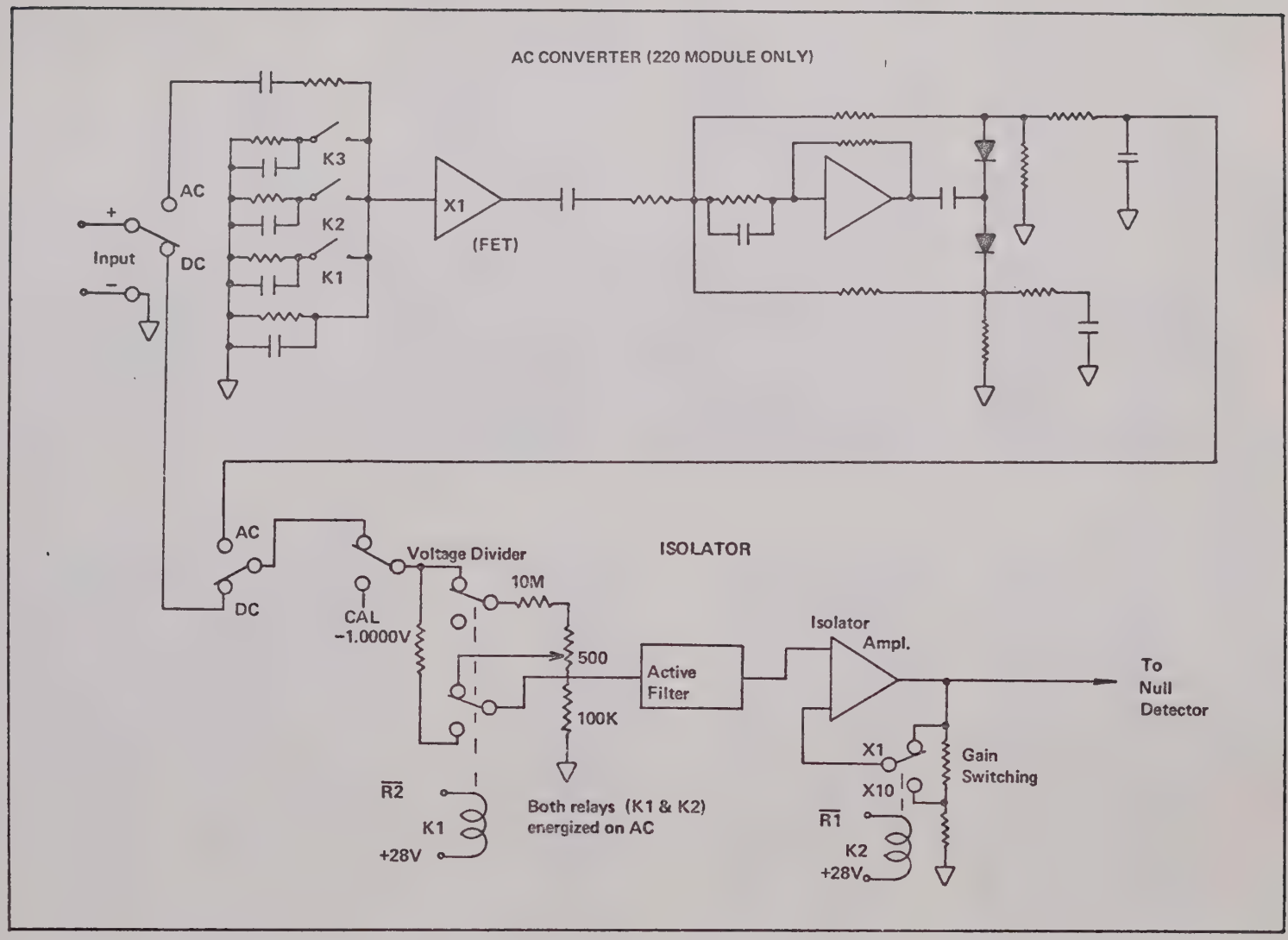


Figure 4.1. Simplified Diagram - Accessory Module

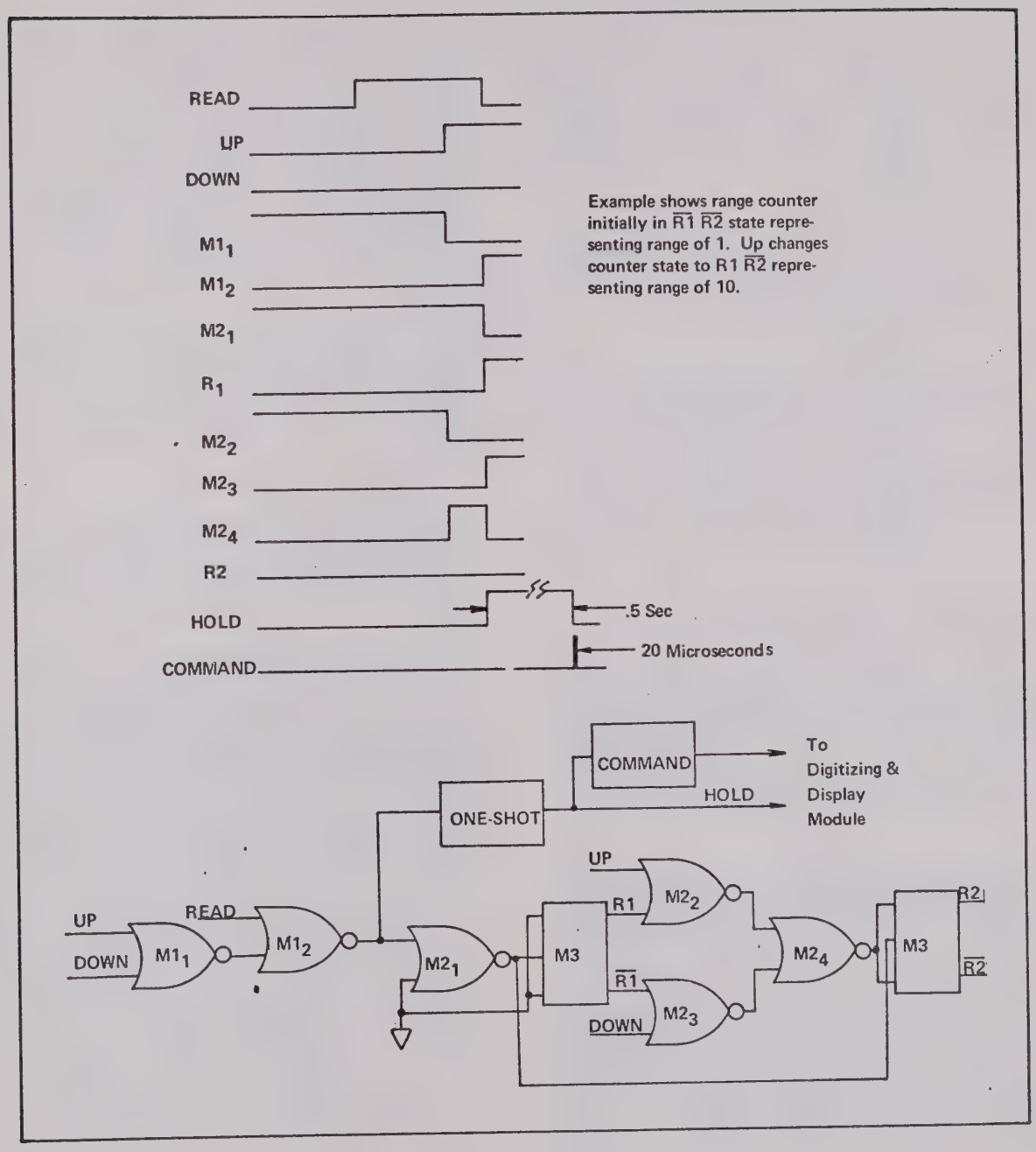


Figure 4.2. Range Control

4.9 AC CONVERTER (Module 220 only)

4.10. With AC selected, the input is routed through the AC Converter before entering the Isolator (figure 4.1). AC ranging is accomplished by a voltage divider network. One RC circuit provides a permanent impedance to reference common for the one-volt range. Relays K1, K2 and K3 add additional impedance to common for the 10, 100, and 1000-volt ranges.

4.11. The scaled input is applied to a unity-gain amplifier that provides isolation and also drives a shield guarding the range relays.

4.12. Rectification takes place in a unity-gain amplifier having polarity-sensitive feedback paths. A half-wave output is taken from the negative feedback leg and applied to the Isolator. In AC mode, the Isolator feedback/voltage divider combination is set to a gain of ten.

4.13 RANGE CONTROL (Figure 4.2)

4.14. Ranging of the instrument is controlled by a two-stage flip-flop counter driven by control signals from the Digitizing and Display Module. These Control Signals are Up Range, Down Range and Read.

4.15. Up Range is true when the instrument is not on the highest range (1000) and the counter is 12000. Down Range is true when the instrument is not on the lowest range (1) and the counter is 00999 or less. Read is true during the measurement period (in the Digitizing and Display Module) of 13 ms. The negative-going edge of this signal indicates the end of the measurement.

4.16. The counter counts up or down in response to the Up Range and Down Range control signals. The state of the flip-flops corresponds to the codes and ranges listed in table 1. A manually-selected range "forces" the flip-flops to the proper state by clamping the appropriate counter outputs to common.

4.17. A one-shot circuit provides a timeout (delay) of about 0.5 sec. at the end of a measurement period to allow time for ranging and for settling time of analog circuits. During this period, the HOLD line goes positive. This line is tied to the input of the control logic circuits in the Digitizing and Display Module where the positive level prevents a new reading from being taken.

4.18. When operating in a selected range, rather than autorange, the HOLD line is permanently strapped to common by the range switch and new readings are allowed during a range changing attempt.

4.19. At the end of the Timeout, a Read command consisting of a positive pulse is sent to the control logic circuits to command a new reading.

4.20 ACTIVE FILTER

4.21. The filter (figure 4.3) is a three-pole broadband active filter used in both AC and DC measurements. The circuit, a modified gaussian filter, provides normal mode noise rejection of 60 dB at 60 Hz increasing 18 dB per octave to 80 dB.

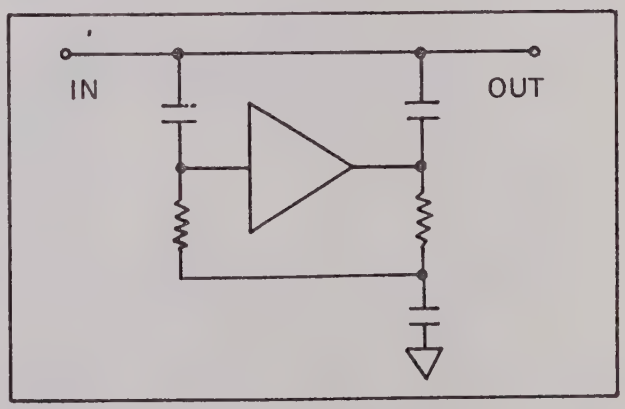


Figure 4.3. Active Filter

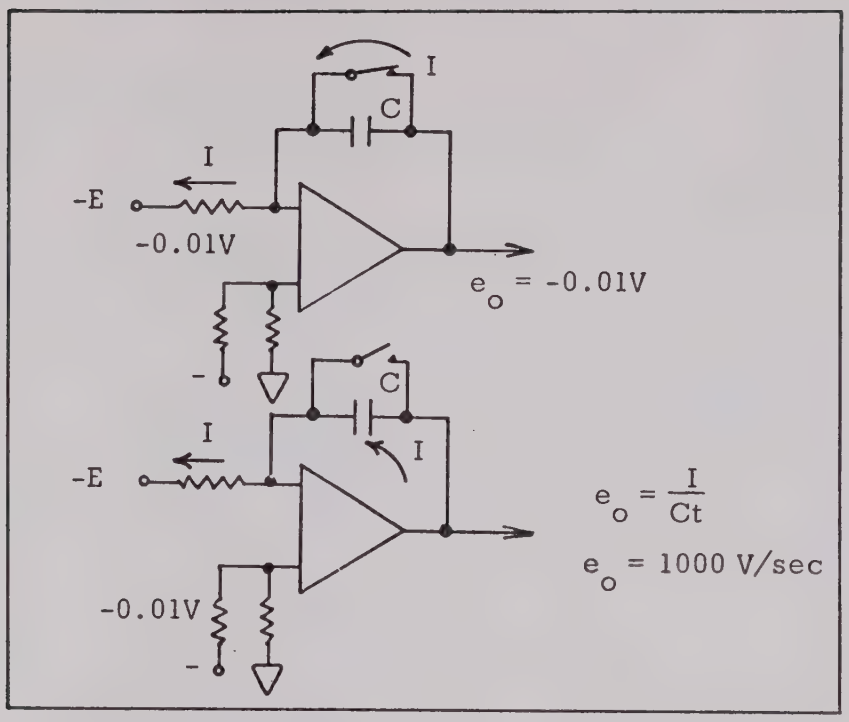


Figure 4.6. Ramp

input current, the ramp becomes a reference by which voltage measurements can be made. Prior to the initiating of a read cycle, a low-leakage switching transistor, shunting the integrating capacitor, is conducting. This causes the output of the ramp amplifier to maintain a voltage level of approximately -10 millivolts determined by a fixed voltage divider. At the start of a read cycle, the switching transistor is turned off, allowing the capacitor to charge and the ramp output voltage goes positive at a rate of one volt per millisecond. The negative bias to the input (voltage divider) allows the ramp time to settle prior to passing through zero volts.

4.28 INTERNAL REFERENCE (Figure 4.7)

4.29. The internal reference voltage is generated by a highly stable zener diode and, in conjunction with a resistor, draws a precise current from the ramp. The zener is supplied with a specific current by the four-stage reference amplifier which allows the reference to operate at its zero temperature coefficient. Because loading on the reference zener is constant, the reference voltage is taken directly from across the zener terminals, without requiring further buffering.

4.30 NULL DETECTOR (Figure 4.8)

4.31. The Null Detector is an open loop high-gain amplifier that determines when the ramp output and accessory module output are of equal potential.

4.32. Prior to a Read Command, the output of the Accessory Module, in conjunction with the output of the Auto Polarity, produces a current drain from the summing node at the input to the Null Detector. Another current drain is produced by a resistor connecting the Null Detector summing node to the output of the ramp (the output, prior to the read command, is at -10 millivolts). Upon receipt of the read cycle, the ramp output goes positive and supplies current to the summing node. When the algebraic sum of the currents equals zero, the Null Detector signals the ramp to reset and the counter to stop.

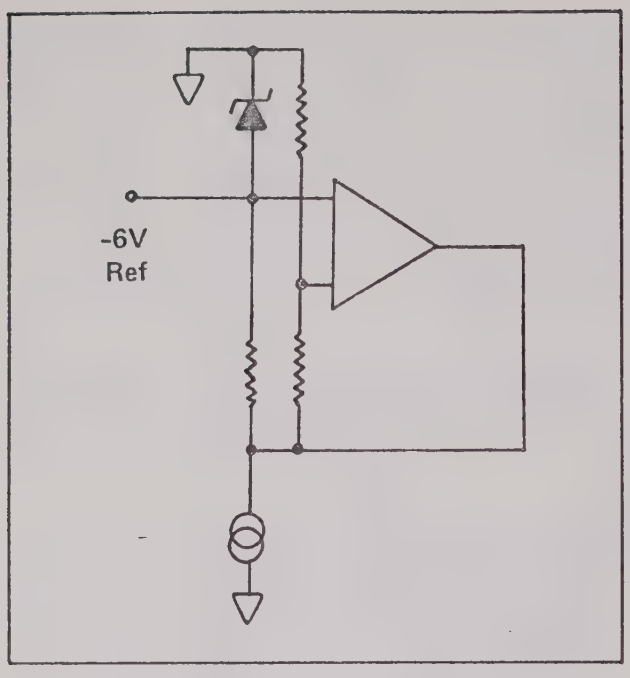


Figure 4.7. Internal Reference

4.33 BINARY COUNTER (Figure 4.9)

4.34. The counter digitally measures the time required for the ramp to reach the potential of the Accessory Module output. Prior to a read command, the counter is at zero and $\overline{Q}$ of the precount flip-flop is true, inhibiting the 10's decade. When the DMM is commanded to read, clock pulses are fed into the 1's decade, causing the decade to count. On the tenth count, a pulse appears at the input of the NOR gate feeding the 10's decade, but is blocked by the positive bias of $\overline{Q}$ of the precount flip-flop. At the same time, the precount flip-flop is reset and the counter is again at all zeros. The counter begins counting for a second time, but without the 10's decade being inhibited. The counter continues to count until stopped by the Null Detector or the overload circuitry. The first ten counts of the binary counter allow for the settling time of the ramp generator. The DMM is calibrated so that the ramp output crosses the zero volts axis at precisely the same instant that the binary counter begins its second count.

4.35 CONTROL LOGIC

4.36. The control logic covers the four logic circuits which program the various functions of the DMM.

4.37. Rate Control. This circuitry determines the number of readings taken by the DMM for a given time period (figure 4.10). Under normal reading conditions, the rate control allows the DMM to take four readings per second. During a range change, a timeout is generated and inhibits further readings until the change is complete. At completion, a read command pulse is generated, causing the DMM to take a new reading. Timing for the read rate circuit is controlled by a unijunction oscillator that produces a six-millisecond pulse every 250 milliseconds. The pulse is applied to two one-shot generators. One-shot (b) produces a 20-microsecond preset pulse. The preset pulse is used to preset the binary counter flip-flops and the precount flip-flop. The preset is also used by the range logic and a portion of the control logic. One-shot (a) produces a 13-millisecond read pulse. The leading edge of the read pulse enables the setting of the polarity indicator and initiates a range change when required (with auto range selected). The read pulse is inverted and used by the read control logic.

4.38. Read Control. The read control circuit coordinates the rate control output with the clock to properly time the start of the ramp and counter circuits. The circuit is shown in figure 4.11. Two NOR gates (c and d) are interconnected to form an R-S type flip-flop. Prior to a reading, the output of of the flip-flop is held false by the positive output of the rate control circuit. The positive level at the input of the NOR gate (a) inhibits the clock pulse from the set side of the flip-flop. At the start of a read cycle, the rate control output goes false and the 20 microsecond reset pulse goes true, inhibiting the clock from setting the flip-flop true. At the end of the preset pulse, the clock resets the flip-

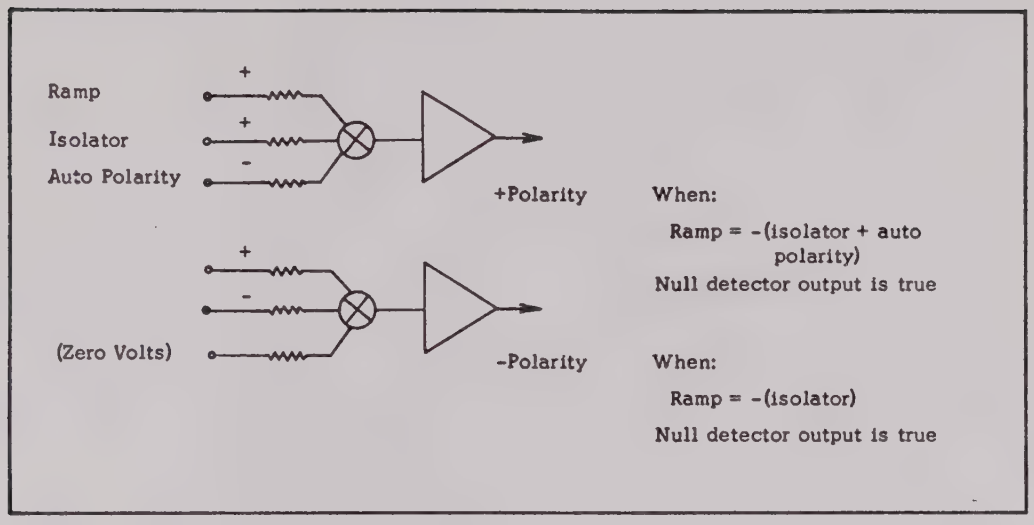


Figure 4.8. Null Detector

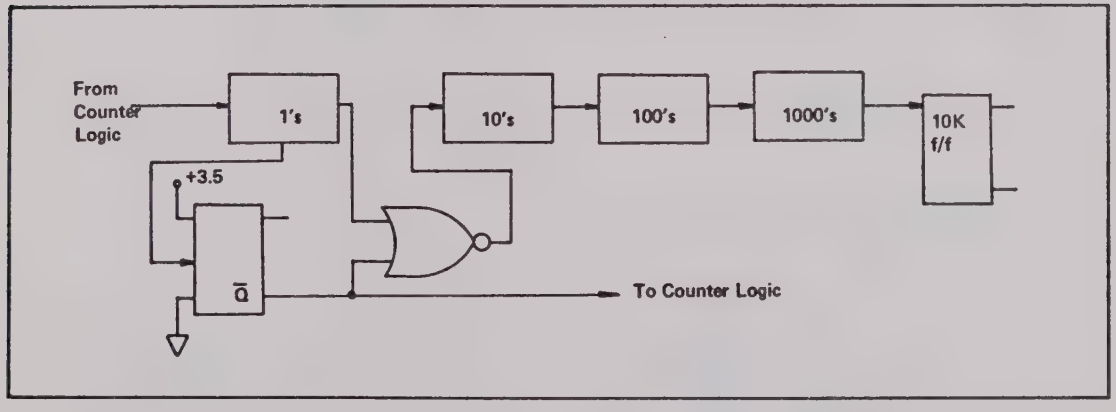


Figure 4.9. Binary Counter

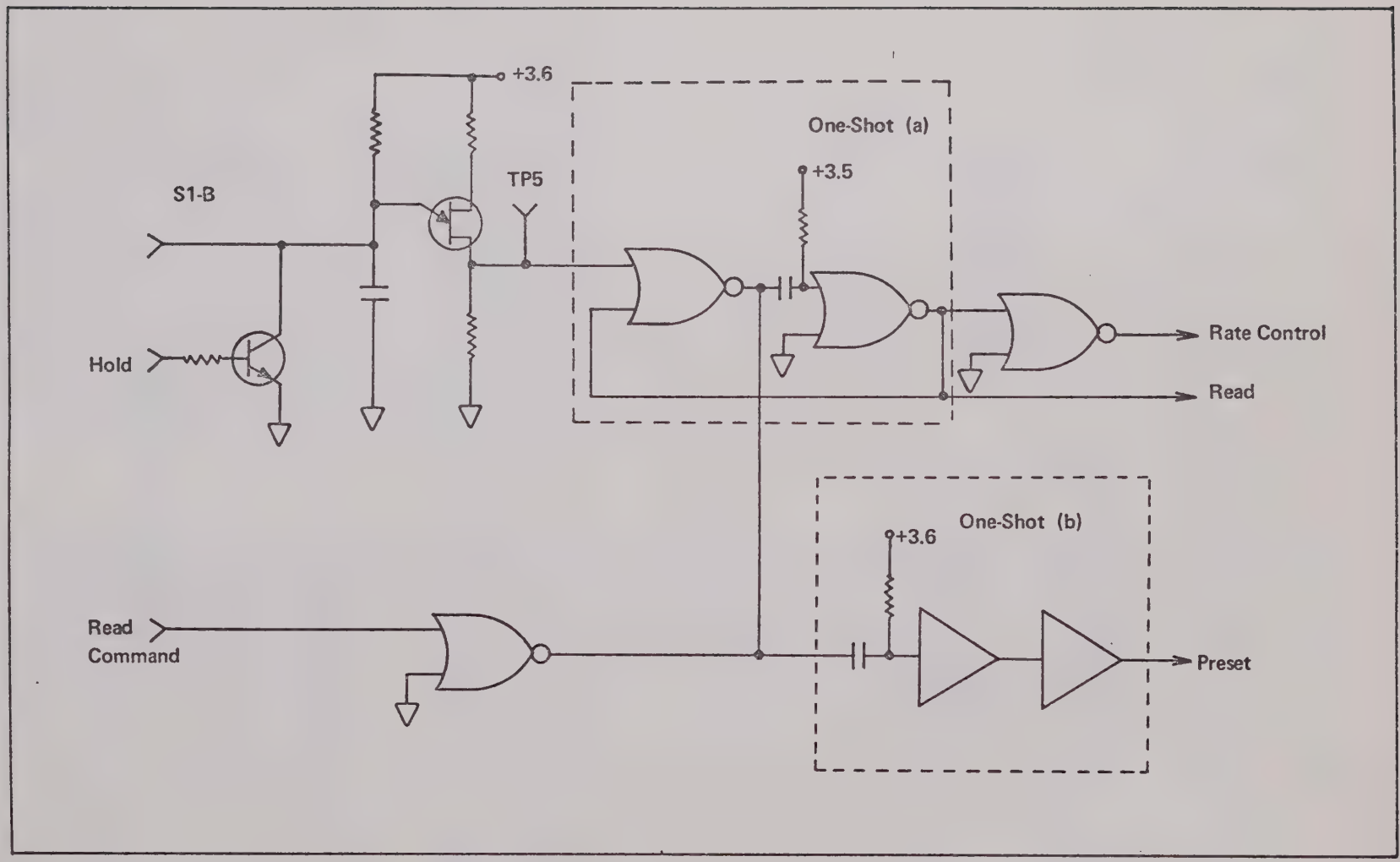


Figure 4.10. Rate Control

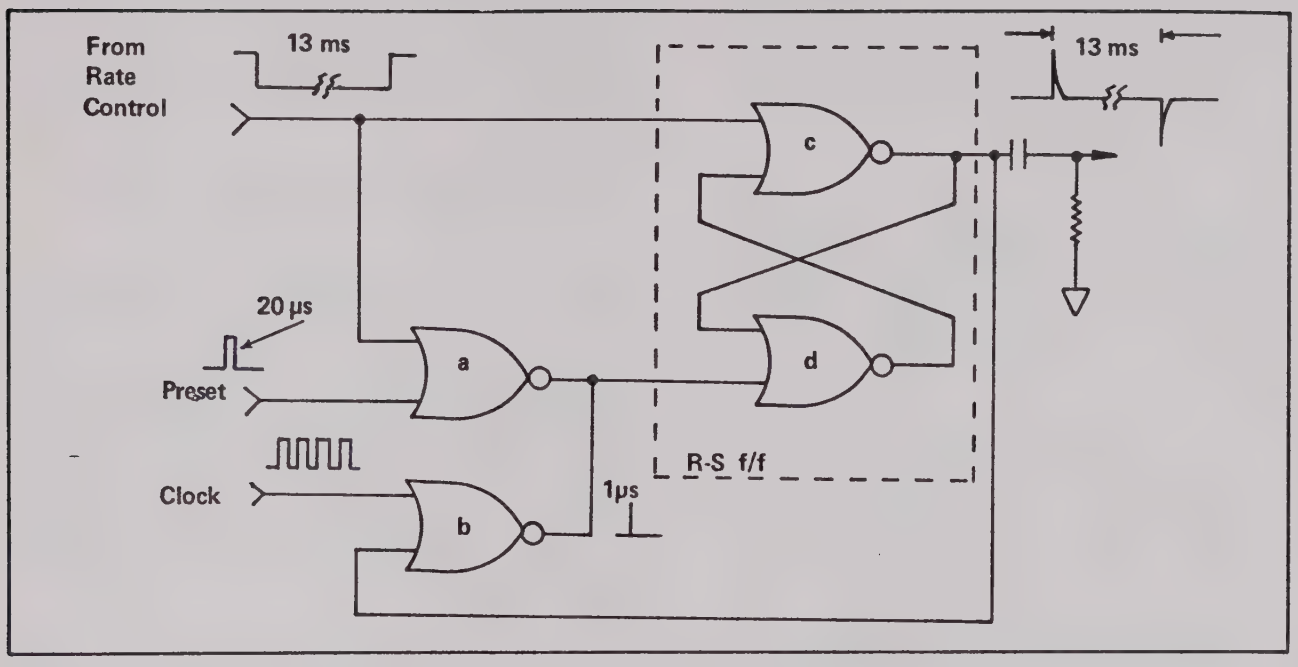


Figure 4.11. Read Control Circuitry

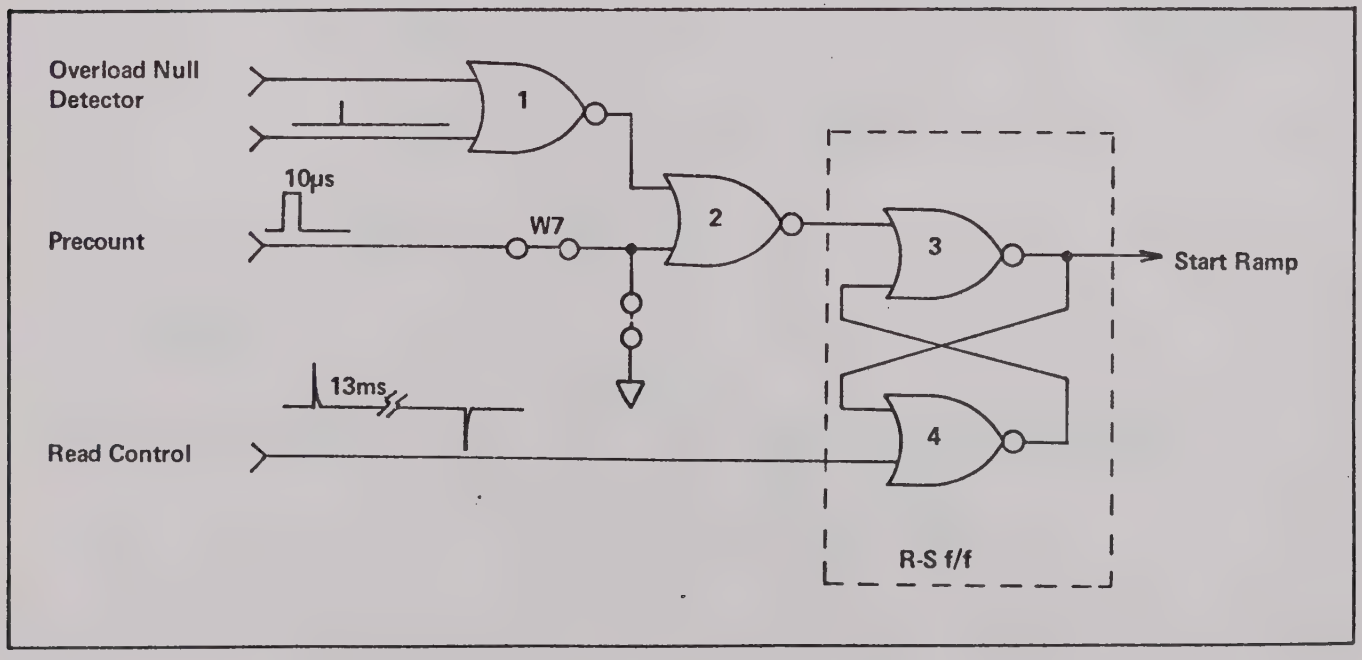


Figure 4.12. Ramp Control

flop. As the flip-flop goes true, the clock pulse is again inhibited, this time by the positive bias at NOR gate (b). The flip-flop remains true for the remainder of the rate control output. The read control flip-flop output is differentiated by an RC network before being applied to the ramp control circuit.

4.39. Ramp Control. The ramp control (figure 4.12) starts and stops the ramp generator. It also controls the blanking circuit and enables the counter control.

4.40. The ramp control flip-flop is set true by the positive-going edge of the read control output. During the precount of the digital counter, the ramp control flip-flop is inhibited from being reset by a precount signal ($\overline{Q}$ of the precount f/f) at the input of NOR gate (2). The flip-flop is then reset on the receipt of a Null Detector output signal or an overload signal at the input of NOR gate (1).

4.41. Counter Control. The counter control circuit (figure 4.13) inhibits the clock train from driving the binary counter until the start ramp goes true.

4.42 BLANKING CIRCUIT

4.43. The blanking circuit lowers the positive supply voltage to the readout tubes causing them to extinguish or blank. Blanking occurs when the start ramp is positive, causing the blanking transistor to conduct.

4.44 RANGE LOGIC (Figure 4.14)

4.45. The range logic generates the information required by the auto range circuitry of the Accessory Module to produce a range change. An up range signal is generated by a logic false appearing at both inputs of NOR gate (a): $\overline{\text{OVERLOAD}}$ and HIGHEST RANGE. $\overline{\text{OVERLOAD}}$ is the $\overline{Q}$ output of the overload flip-flop and is false in an overload condition. HIGHEST RANGE is false when an UP range is possible.

4.46. A down range signal is generated by a logic false appearing at both inputs of NOR gate (b): LOWEST RANGE and the Q output of the DOWN range flip-flop. LOWEST RANGE is false if a DOWN range is possible and Q is set false at the start of a read cycle by the reset pulse. The DOWN

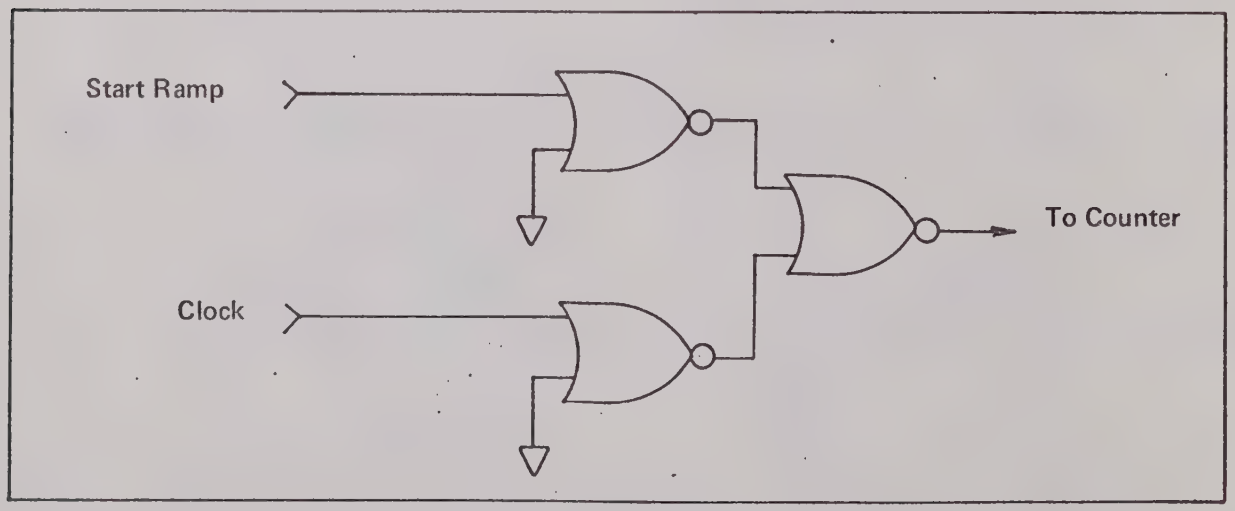


Figure 4.13. Counter Control

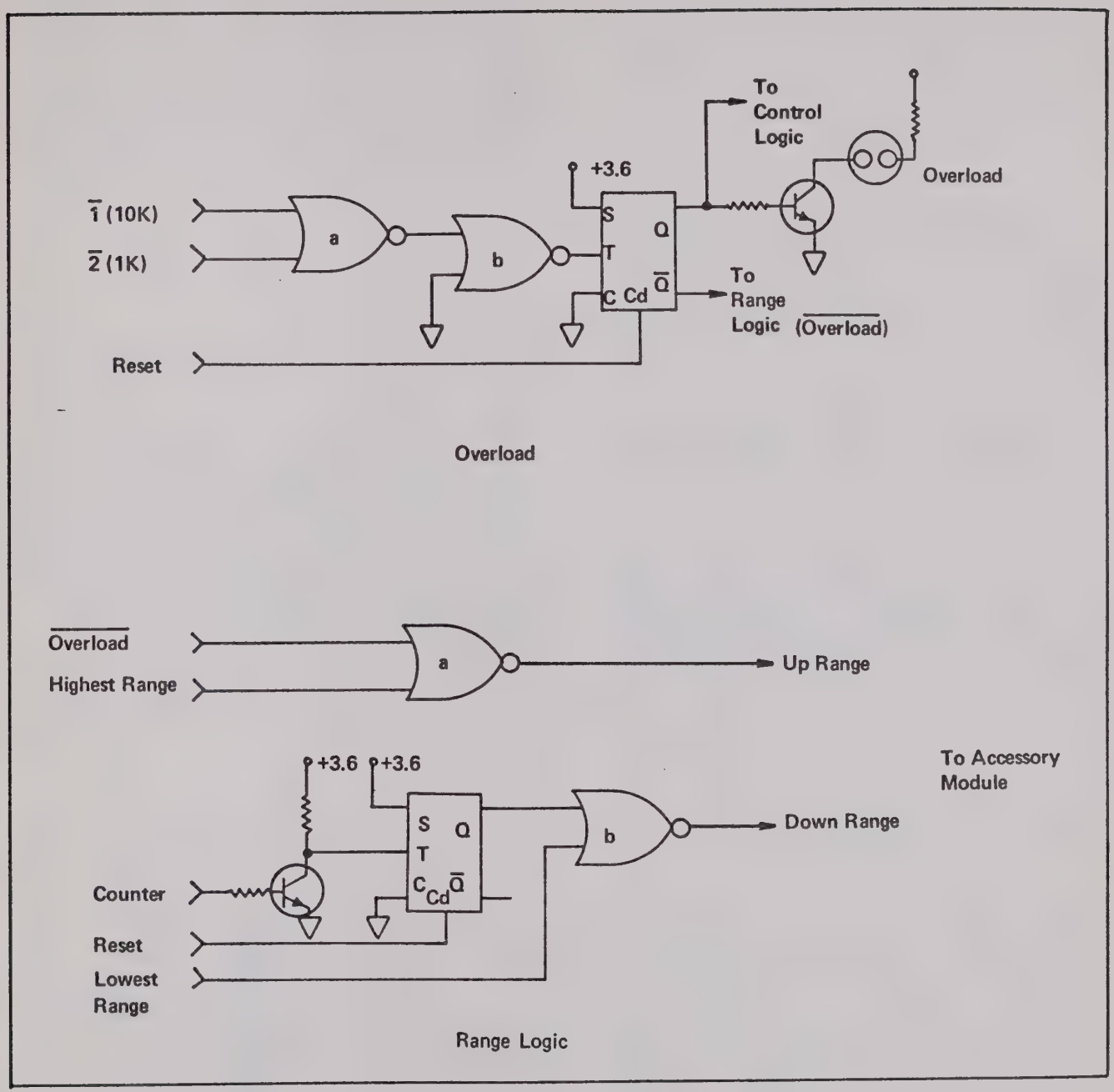


Figure 4.14. Overload and Range Logic

range signal is true until the counter reaches 1000. The flip-flop is set by an inverted signal from the counter. The inverted signal goes true at a count of eight hundred and false again at a count of one thousand, the negative side of the pulse setting Q to logic true.

4.47. Notice that the UP range remains false even in an overload condition when the instrument is in the highest range and the DOWN range remains false during a read cycle when the instrument is in the lowest range.

4.48 OVERLOAD

4.49. The overload circuit detects when the digital counter has reached 12,000 or full scale. A signal is sent to the control logic and the overload indicator lights.

4.50. At the beginning of a reading, the reset pulse sets Q false and $\overline{Q}$ true. The inputs of NOR gate (a) consist of $\overline{2}$ (not 2) of the 1K decade and $\overline{1}$ (not 1) of the 10K flip-flop (actually the zero driver side of the flip-flop). Either one or both of these inputs are true until the counter reaches 12,000. At this time, the output of NOR gate (a) negative-going edge of this pulse causes the overload flip-flop to change state (Q goes true and $\overline{Q}$ goes false). The positive level at Q drives the overload indicator on and signals the control logic to stop the counter and ramp. $\overline{Q}$ is used by the range logic.

4.51 POLARITY SENSE (Figure 4.15)

4.52. The polarity sense circuitry controls the polarity indicator. The Auto Polarity, which automatically compensates for changes in polarity of the input signal, drives the single-staged differential amplifier of the polarity sense circuit. The outputs of the amplifier drive the set (s) and the clear (c) inputs of the J/K flip-flop. The negative going side of the read pulse (following the read cycle) signals the flip-flop to change state if required.

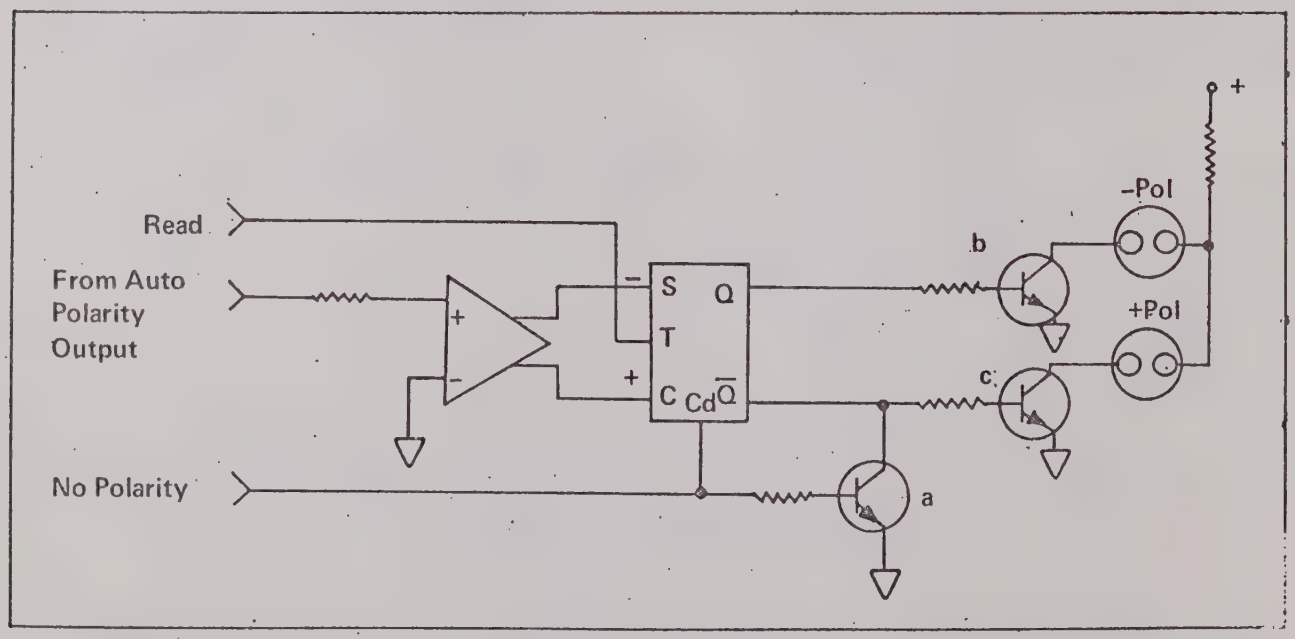


Figure 4.15. Polarity Sense

The flip-flop outputs Q and $\overline{Q}$ control the driver transistors of the minus and plus polarity indicators. The NO POLARITY input is set true when AC is selected. The positive bias at Cd forces Q false and transistor (a) shunts $\overline{Q}$ to false, causing both the minus and plus polarity indicators to remain off.

4.53 CLOCK

4.54. The clock circuit produces a symmetrical 1 MHz stable timing signal for driving the counter circuit.

4.55. The circuit, as shown in figure 4.16, uses two NOR gates interconnected to form a crystal controlled free-running multivibrator. Referring to figure 4.31 the oscillator operates as follows: Assume e1 is false, biasing Q4 off. C is driven negative, turning Q3 off and causing e2 to go true. e2 at true biases Q1 on. C charges positively through R2 until Q3 is biased on (approximately 0.85 volts). At this time, e2 goes false, Q1 is biased off and Q2 is driven off by crystal (x) being driven negative. With both transistors Q1 and Q2 driven off, e1 goes true, biasing Q4 on. R1 charges X until Q2 turns on, setting e1 to false. The operation then repeats itself.

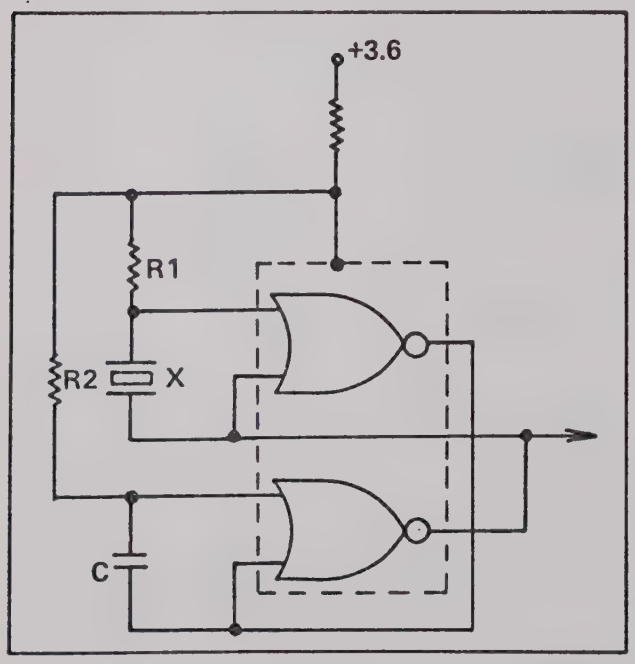


Figure 4.16. Clock

4.56 BCD TO DECIMAL DECODING

4.57. The four J-K flip-flops, A_1, A_2, B_1, and B_2 (figure 4.17) drive the BCD-to-decimal converter and carry the logic weights of 1, 2, 4, and 8, respectively. The four flip-flops and two NOR gates are interconnected to convert ten input pulses into ten separate BCD coded outputs ranging in numerical value from zero to nine.

4.58. At the beginning of a read cycle, the reset pulse is applied to all of the counter flip-flops, setting the outputs false (negative true logic). The logic levels of various points in the counter are shown in the timing diagram of figure 4.17.

4.59 POWER SUPPLY

4.60. 3.6 Volt Supply. The +3.6 volt supply is used by all of the micrologic circuitry and in circuits used to directly drive the integrated circuits.

4.61. As shown in figure 4.18, voltage to the supply is provided by a full wave rectified 8 volts from a center-tapped secondary and diodes CR5 and CR6. Reference for the supply is taken from across zener diode CR11. The zener voltage is compared with a fractional part of the output voltage and the error signal used to drive a Darlington coupled emitter follower, Q2 and Q3. The output voltage is taken from the emitter of Q3 and added regulation is provided by capacitor C16.

4.62. High Voltage Supplies. The 300-volt supply provides the anode potential for the nixie readout

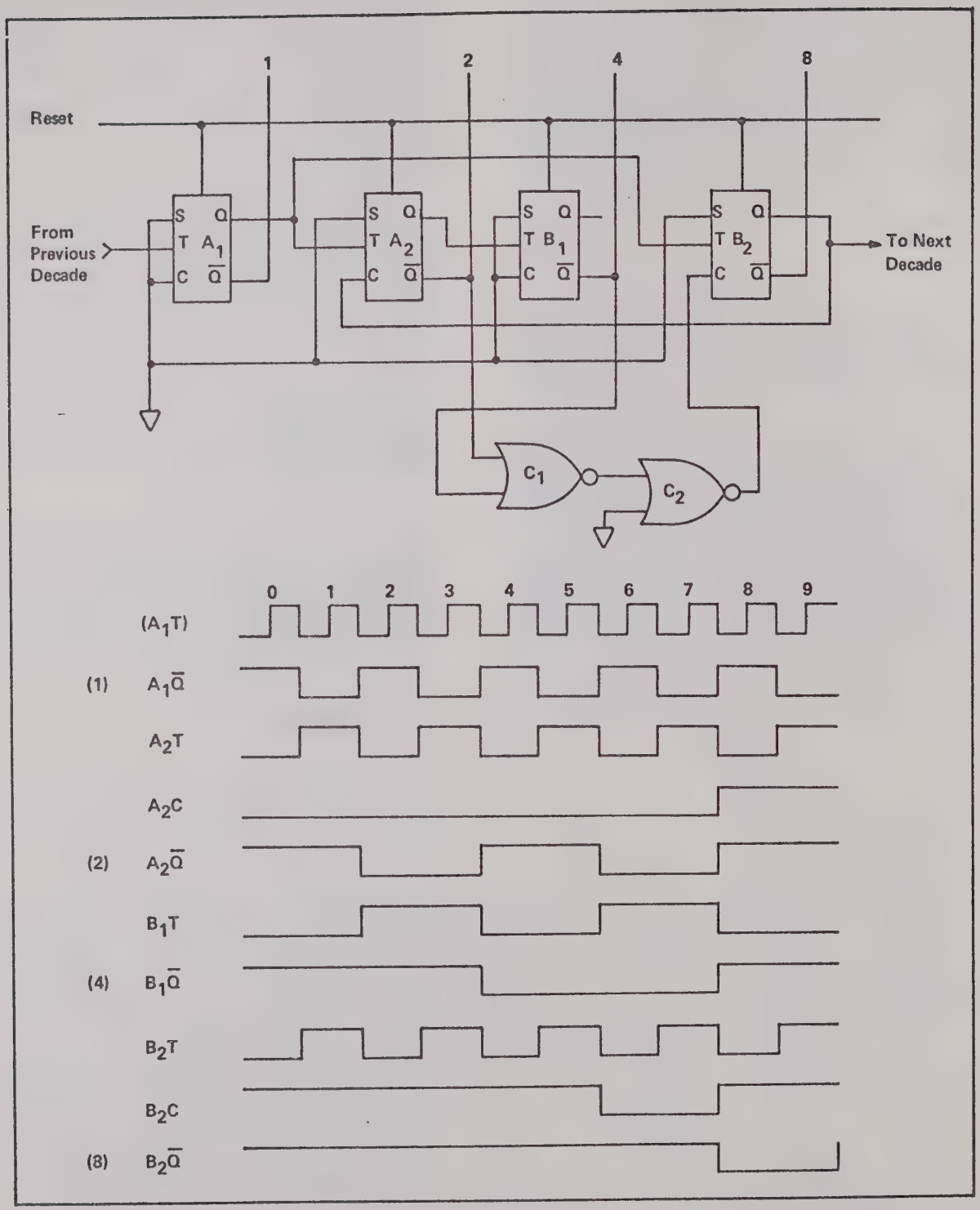


Figure 4.17. Counter Logic

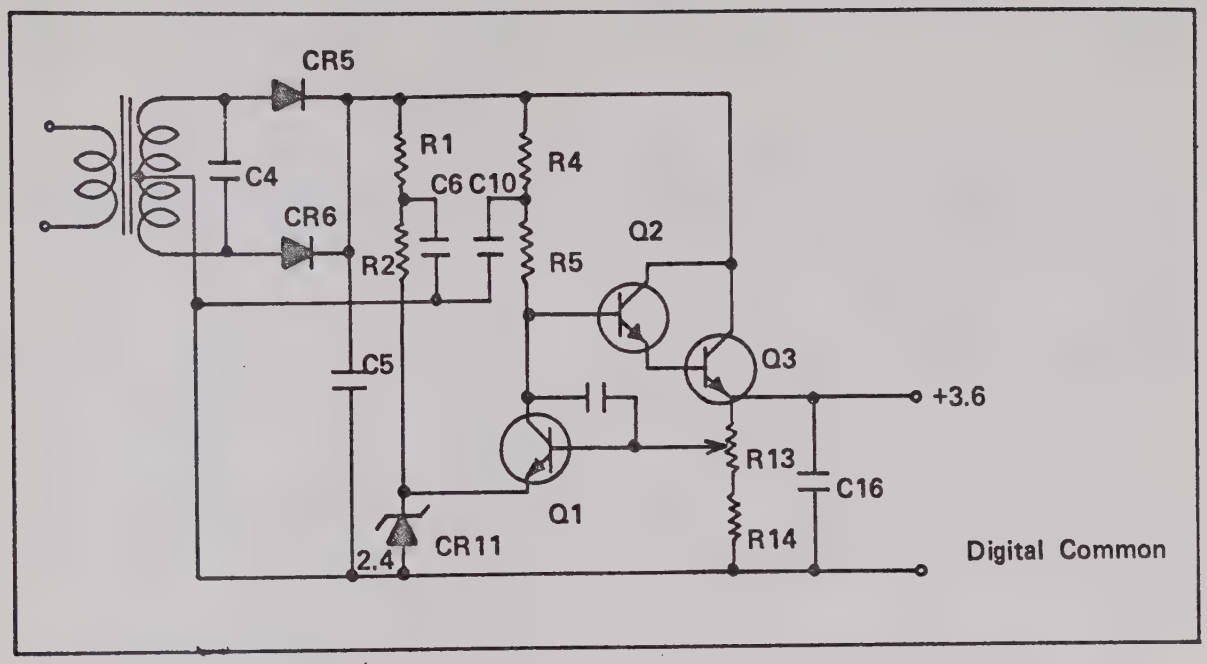


Figure 4.18. 3.6-Volt Supply

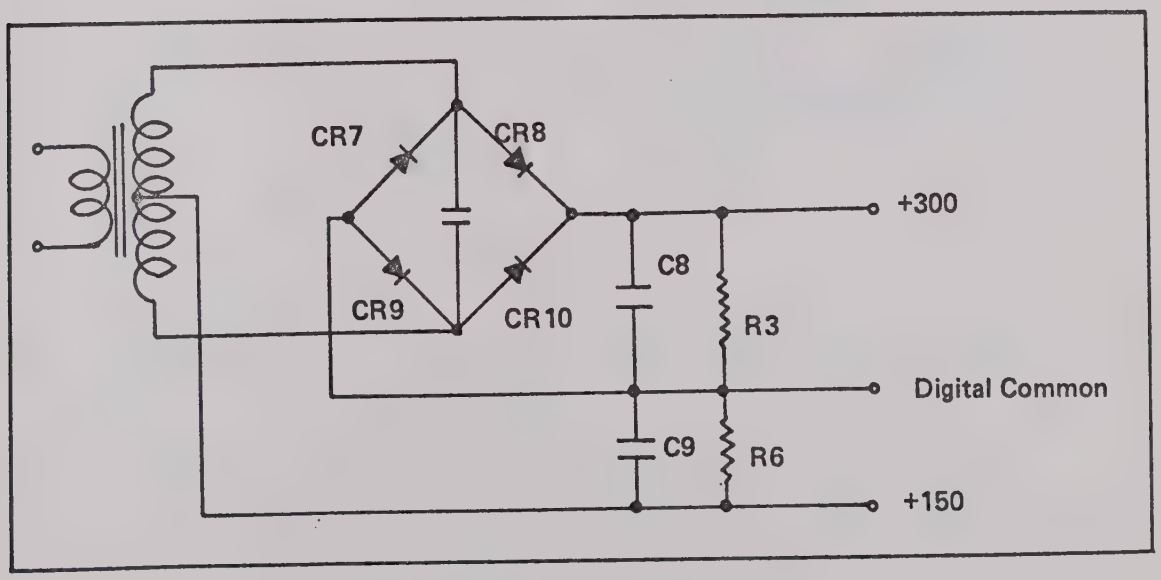


Figure 4.19: High Voltage Supply

tubes. The 150-volt supply provides the required potential for operating the polarity and overload indicators.

4.63. As shown in figure 4.19, the 300-volt output is generated across the bridge rectifier consisting of diodes CR7, CR8, CR9, and CR10. Capacitor C8 provides filtering. The 150-volt output is taken from the center tap of the secondary used for the 300-volt supply. Diodes CR7 and CR9 carry the current of both the 300 and 150-volt supplies. Filtering for the 150-volt output is provided by C9.

4.64. 28 Volt Supplies. The plus and minus 28 volt supplies are used both in the Accessory Module and in the analog circuits of the Digitizing and Display module.

4.65. Referring to figure 4.20, diodes CR2 and CR4, in conjunction with the secondary winding center tap, form the full-wave rectified +28 volt supply. The -28 volt supply uses the same center tap and diodes CR1 and CR3. Capacitor C2 and C3 are used for filtering.

4.66. 18 Volt Supplies. The plus and minus 18 volt supplies are regulated and are used in the same areas of the DMM as the 28 volt supplies.

4.67. Rectified voltage to power the 18 volt supplies is provided by the plus and minus 28 volt supplies. In the +18 volt supply, zener diode CR12 provides a reference of approximately 18.5 volts which is applied to the base of emitter follower Q4. The +18 volts is taken directly from the emitter of Q4 and current from the supply is limited by collector resistor R8. The -18 volt supply uses the same principle as the +18 volt supply. Reference is taken from zener diode CR13 and the -18 volts is taken from the emitter of Q5. Commons for all of the supplies are tied together.

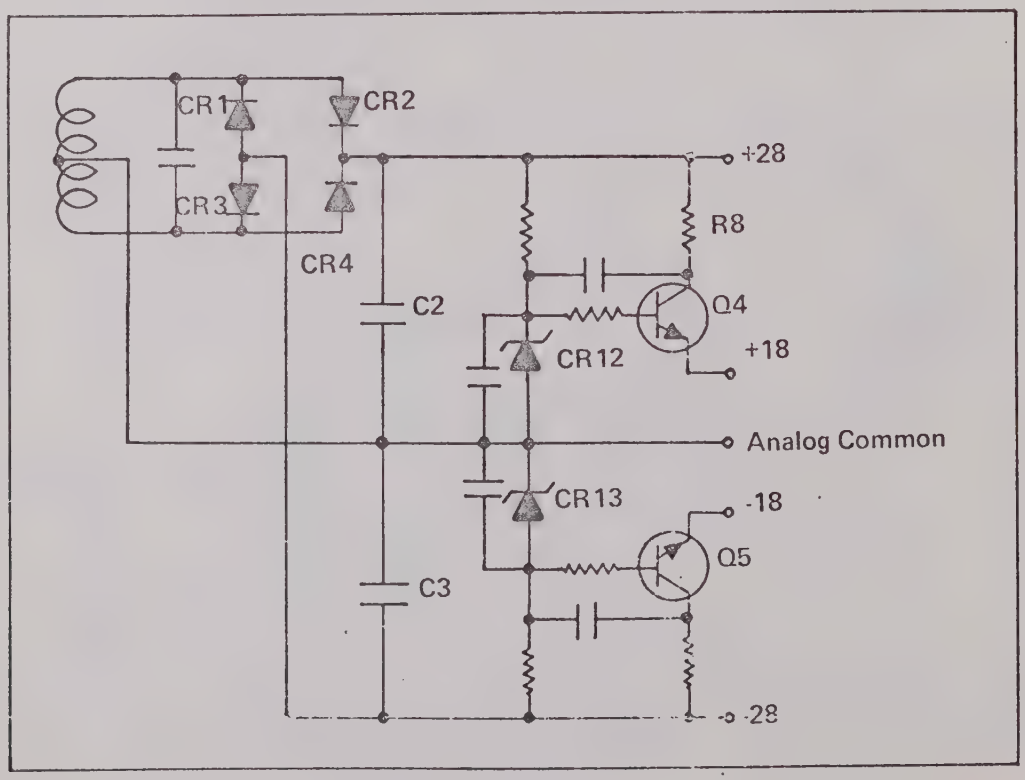


Figure 4.20. 28/18 Volt Supply

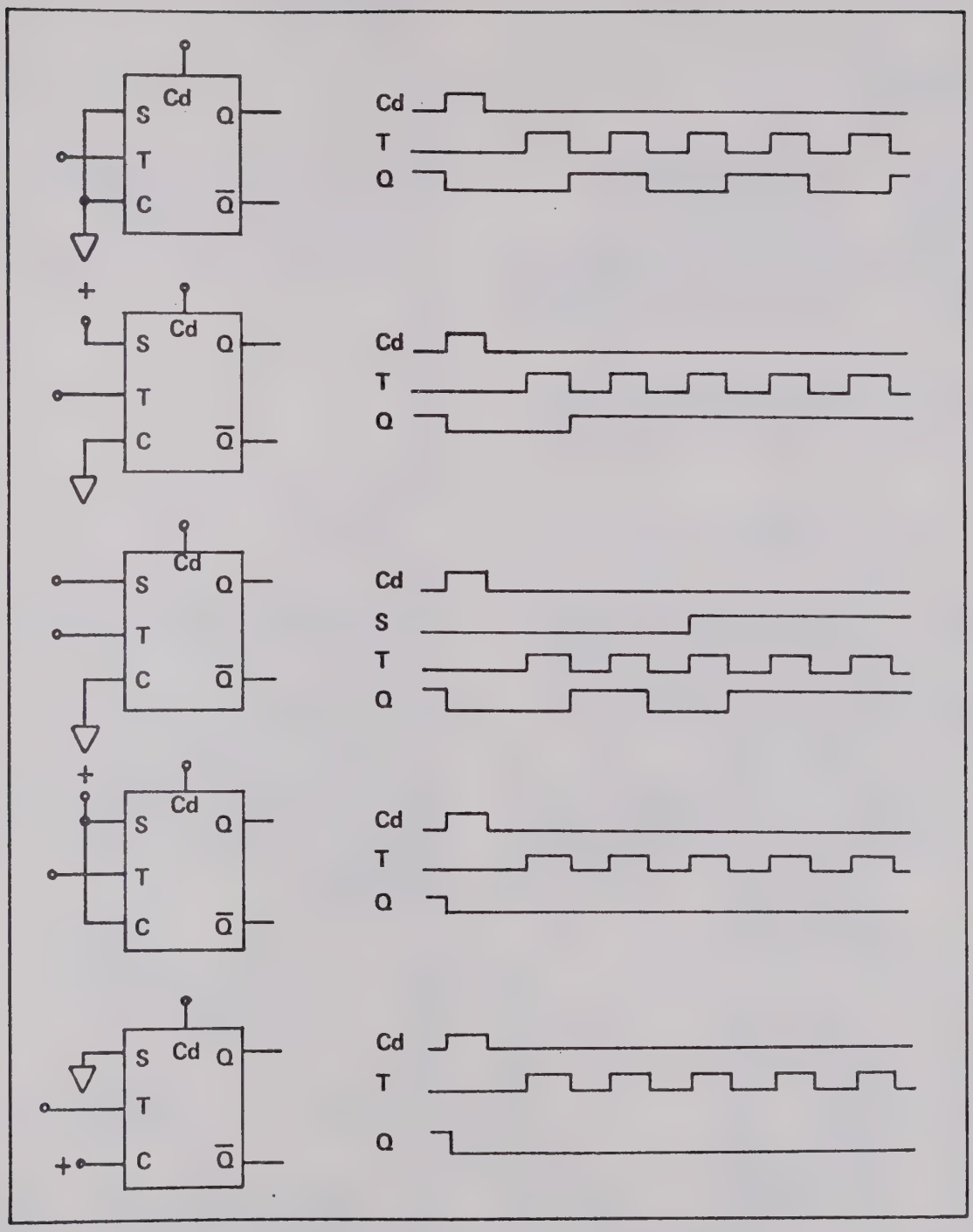


Figure 4.21. Flip-Flop Operating Modes

4.68 INTEGRATED CIRCUIT ELEMENTS

4.69. The following basic integrated circuits are used in the DMM:

MC723P	J-K Flip-flop
MC790P	Dual J-K Flip-flop
CML9960	Decoder Display Driver
MC799P	Dual Buffer
MC724P	Quad Two-input NOR Gate
MC717P	Quad Two-input NOR Gate

4.70. The physical and mechanical characteristics of each of the basic elements are tabulated in figures 4.26 through 4.30 at the end of this section.

4.71 J-K FLIP-FLOP OPERATING MODES

4.72. Shown in figure 4.21 are five common modes of operating the J-K flip-flop in the Series 4400 DMM. Output Q, prior to receipt of the Cd pulse, is determined by the previous state of the flip-flop. Output $\overline{Q}$ is the inverse of Q.

4.73. Figure 4.22 shows the interconnecting of the two NOR gates so as to obtain an R-S flip-flop.

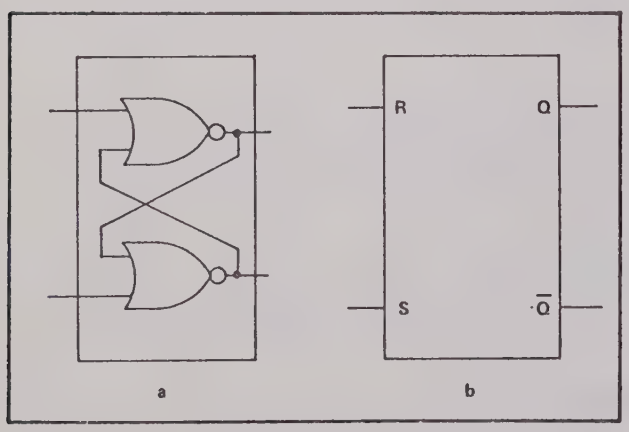


Figure 4.22. Interconnected Nor Gates

4.74 SCHEMATIC IDENTIFICATION OF LOGIC DEVICES

4.75. Reference designators for all devices regardless of type have the letter "M" as a designating letter. This is followed by a number to identify the component uniquely (figure 4.23).

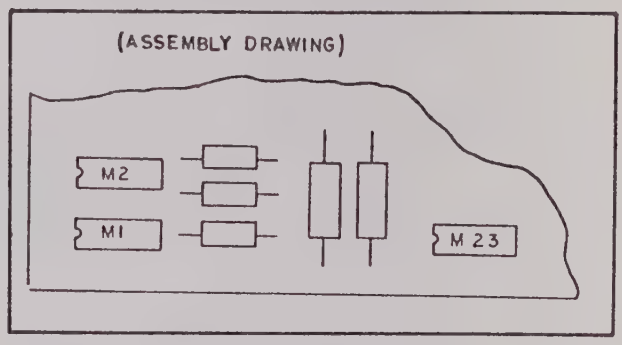


Figure 4.23. Component Identification

4.76. Identification of Logic Function Symbols. Individual logic functions are identified on the schematic by the designator of the logic device in which they appear. In most cases, circuitry for more than one function is encased within the same module. To distinguish between them, an additional letter designator is affixed to that of the device (A, B, C, D, etc.), as required to cover all functions (figure 4.24).

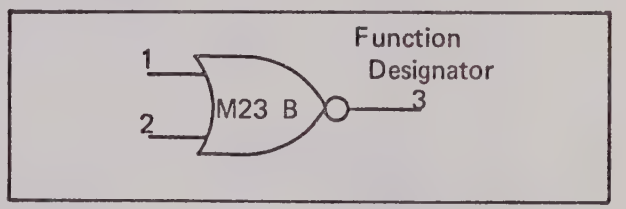


Figure 4.24. Function Designator

4.77. Input-Output Pin Numbers. Module pin numbers are placed outside the function symbols next to the input and output leads.

4.78. Identifying Type of Device. Module (IC element) type is defined on the schematic in note

form. This applies, of course, to the major type used on the schematic. If more than one type of device is used for the same logic function, the least used is defined at the logic symbol.

4.79. Circuit Definition of Logic Devices. A circuit diagram of the logic devices used does not appear on each schematic; rather, schematics in figures 4.26 through 4.30 describe all elements used.

4.80. Restriction on Logic Symbol Usage. On schematics that contain both integrated circuit elements and discrete components, the logic symbols describe only that circuitry which is contained within the devices. In other words, no logic symbols are used to represent a function that is made up of discrete components.

4.81. Standard Symbols. Figure 4.25 shows the standard integrated circuit logic symbols used on Dana drawings.

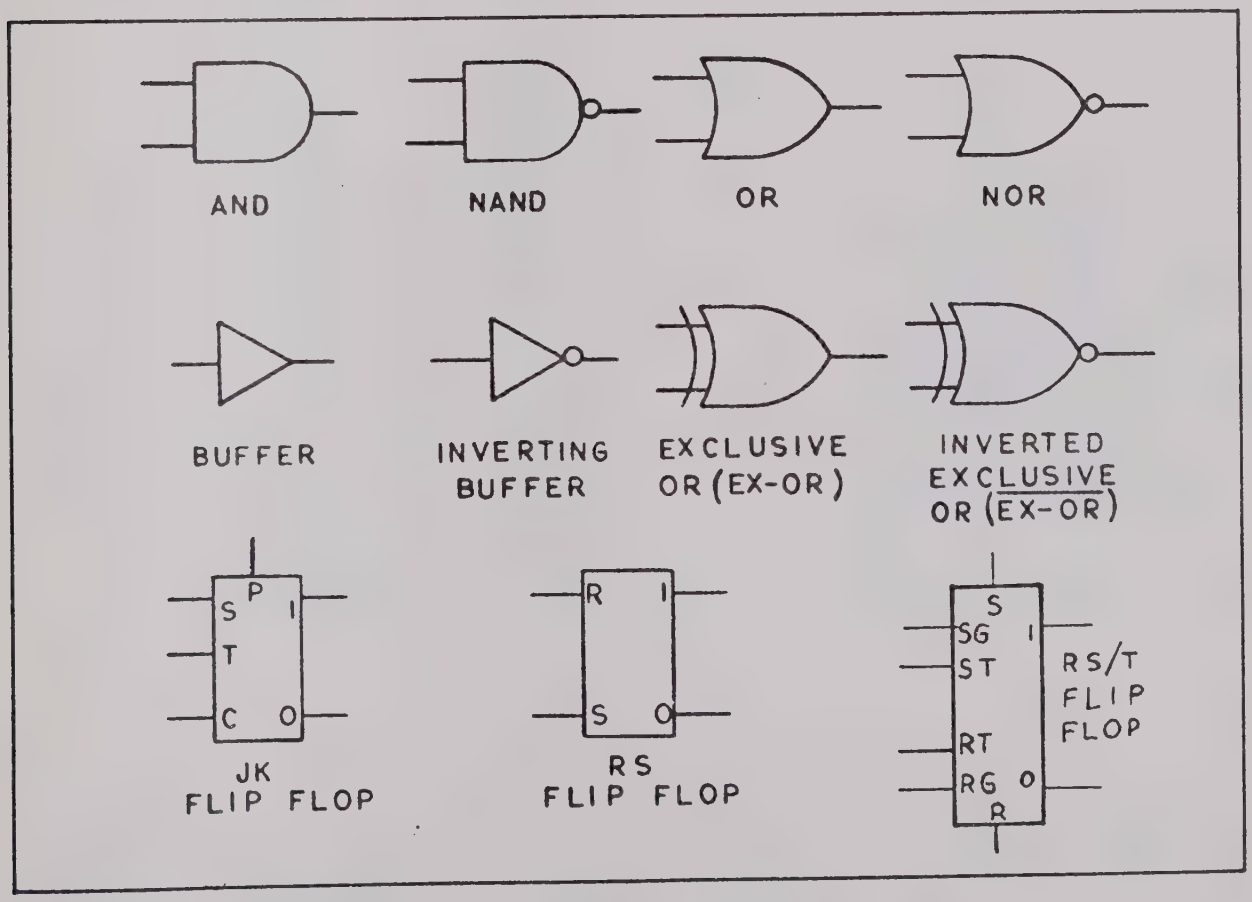
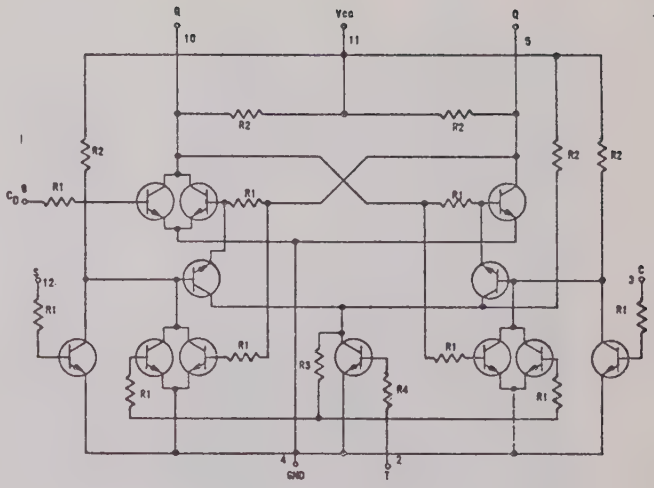


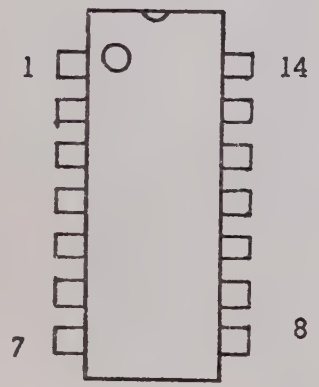
Figure 4.25. Logic Symbols

MC723P J-K Flip-Flop	
R_1	450 Ohms
R_2	640 Ohms
R_3	510 Ohms
R_4	225 Ohms
f_{tog}	4 mHz
V_{off}	+0.46V Max
V_{on}	+0.85V Min
V_{out}	+0.3V Max
Vcc	+3.6V ±10%

TN (NOTE 2)		TN+1 (NOTE 2)	
S	C	Q	$\overline{Q}$
1	1	QN^3	$\overline{Q}N$
1	0	1	0
0	1	0	1
0	0	$\overline{Q}N$	QN^3

(Note 3)





NOTES:

1. Direct input Cd must be low.
2. The time period prior to the negative transition of the clock pulse is denoted Tn and the time period subsequent to this transition is denoted Tn+1.
3. Qn is the state of the Q output in the time period Tn.
4. Clock Pulse (T) inputs must have a fall time within the range of 10ns to 100ns. Fall time is a straightline function from 1V to ground.

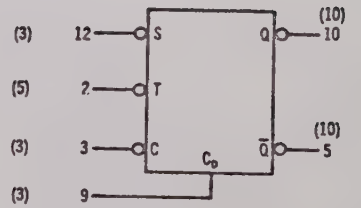
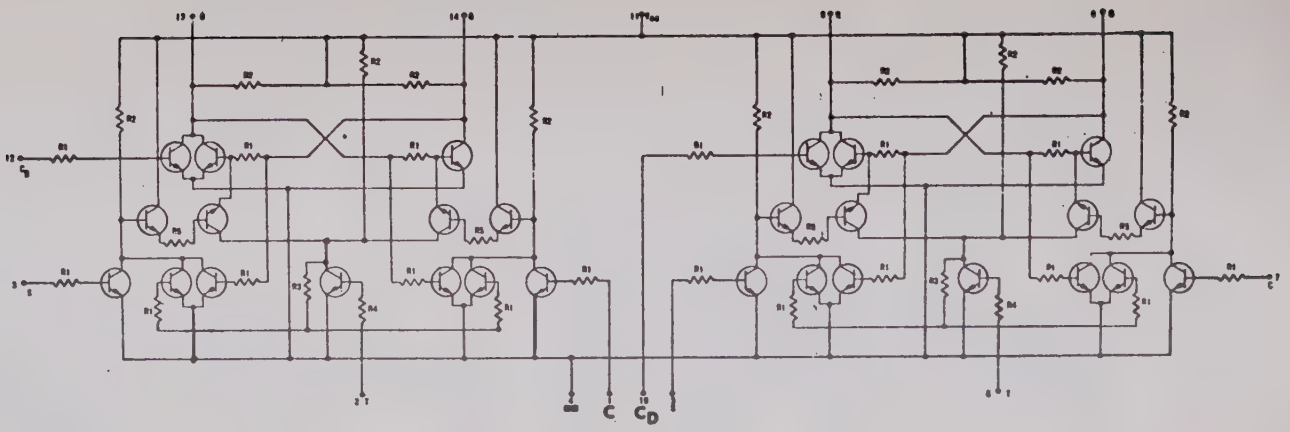


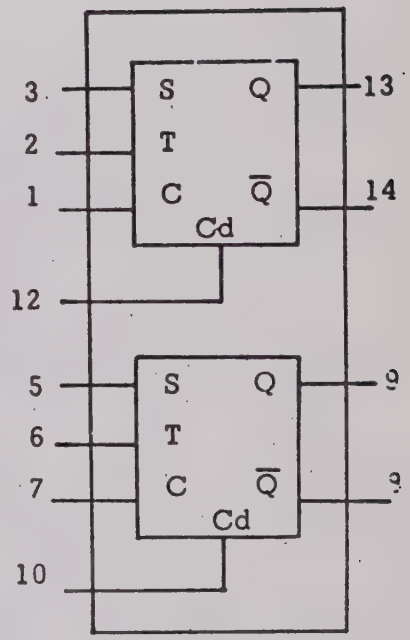
Figure 4.26. J-K Flip-Flop

MC 790 P Dual J-K Flip-Flop	
R_1	450 Ohms
R_2	640 Ohms
R_3	510 Ohms
R_4	225 Ohms
R_5	300 Ohms
V_{off}	+0.46V Max
V_{on}	+0.85V Min
V_{out}	+0.3V Max
Vcc	+3.6V ±10%
f_{tog}	4 mHz



TN (NOTE 2)		TN+1 (NOTE 2)	
S	C	Q	$\overline{Q}$
1	1	QN^3	$\overline{Q}N$
1	0	1	0
0	1	0	1
0	0	$\overline{Q}N$	QN^3

(Note 3)



NOTES:

1. Direct input Cd must be low.
2. The time period prior to the negative transition of the clock pulse is denoted Tn and the time period subsequent to this transition is denoted Tn+1.
3. Qn is the state of the Q output in the time period Tn.
4. Clock Pulse (T) inputs must have a fall time within the range of 10ns to 100ns. Fall time is a straightline function from 1V to ground.

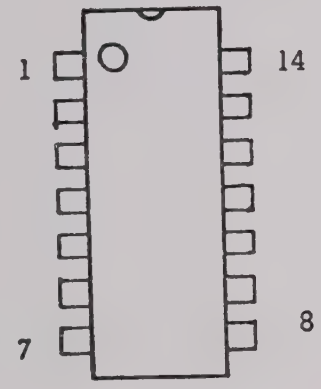
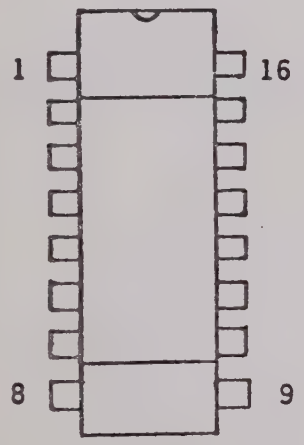
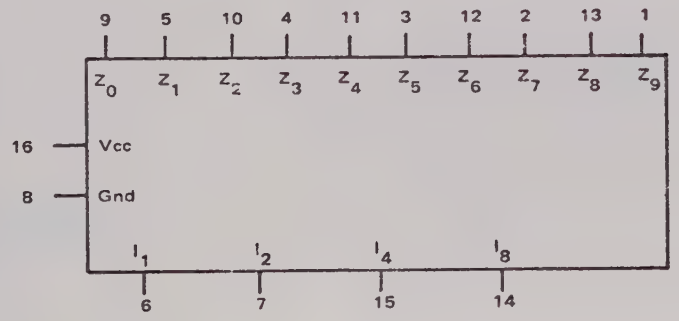


Figure 4.27. Dual J-K Flip-Flop

CML 9960 Decoder Display Driver	
R_1	2K
R_2	4K
R_3	5K
V_{off}	+0.4V Max
V_{on}	+1.0V Min
I_{out}	10.0 Ma Max
Vcc	+4.4V ±25%





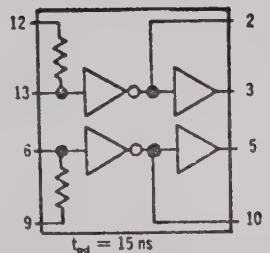
Input

	Digit 0	1	2	3	4	5	6	7	8	9
1	1	0	1	0	1	0	1	0	1	0
2	1	1	0	0	1	1	0	0	1	1
4	1	1	1	1	0	0	0	0	1	1
8	1	1	1	1	1	1	1	1	0	0

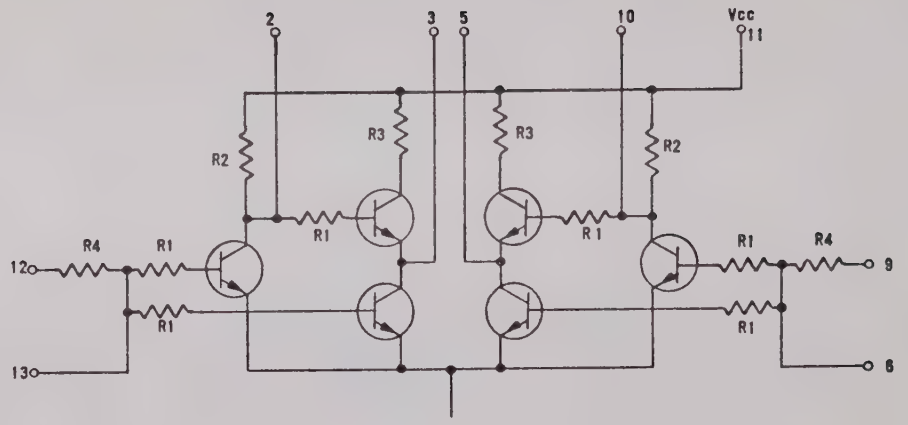
1 = Vcc
0 = Gnd

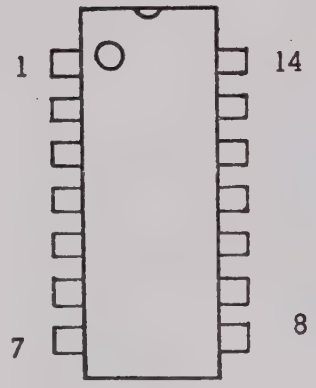
Figure 4.28. Decoder Display

MC 799P Dual Buffer	
R_1	450 Ohms
R_2	640 Ohms
R_3	100 Ohms
R_4	1000 Ohms
V_{off}	+0.46V Max
V_{on}	+0.85V Min
V_{out}	+0.3V Max
Vcc	+3.6V ±10%



Outputs 2 and 3 may not be used simultaneously.
Outputs 5 and 10 may not be used simultaneously.





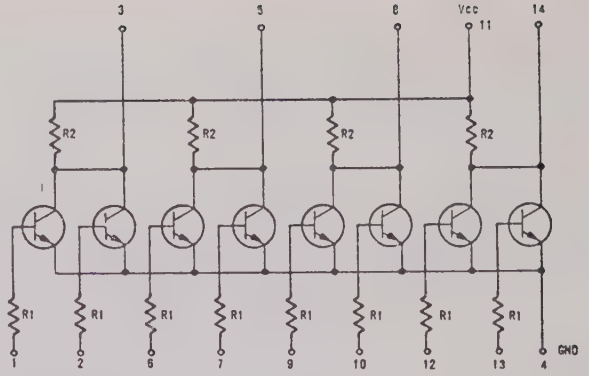
Input					Output			
12	13	6	9		2	3	5	10
0					1			
1					0			
	0					1		
	1					0		
		0					1	
		1					0	
			0					1
			1					0

Figure 4.29. Dual Buffer

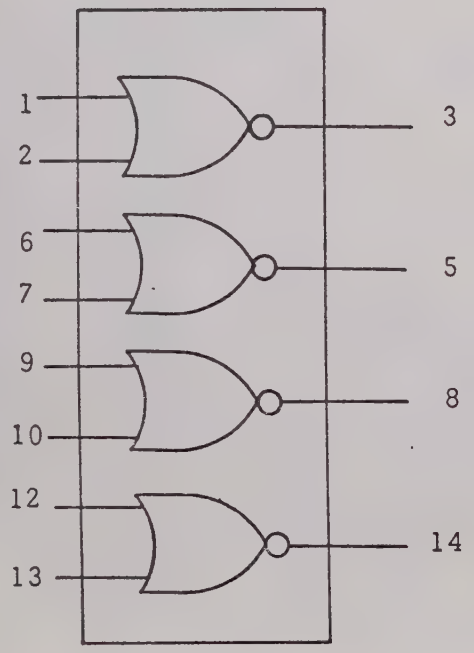
MC 717P
MC 724

QUAD 2-INPUT NOR GATE

	MC717P	MC724P
R_1	1.5K	450 Ohms
R_2	3.6K	640 Ohms
V_{off}	0.46 Max	
V_{on}	0.85 Min	
V_{out}	0.3 Max	
Vcc	3.6 ±10%	



Inputs								Output			
1	2	6	7	9	10	12	13	3	5	8	14
0	0							1			
1	0							0			
0	1							0			
1	1							0			
		0	0						1		
		1	0						0		
		0	1						0		
		1	1						0		
				0	0					1	
				1	0					0	
				0	1					0	
				1	1					0	
						0	0				1
						1	0				0
						0	1				0
						1	1				0



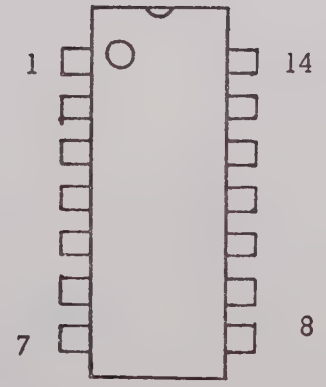


Figure 4.30. Quad Two-Input Nor Gate

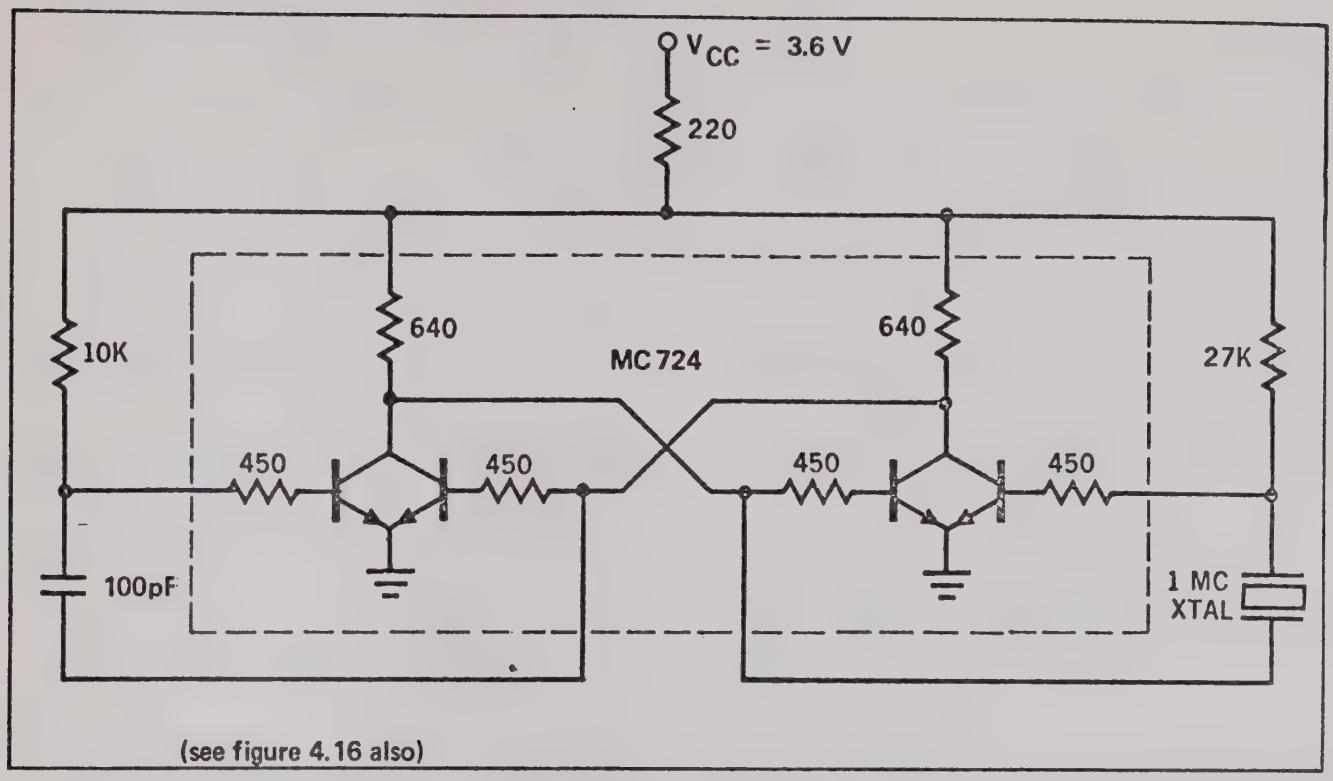


Figure 4.31. MC724 Used as a Crystal Oscillator

SECTION 5

MAINTENANCE

5.1 CALIBRATION

5.2 General. Following is the calibration procedure for the 4400 series DMM. Any necessary maintenance should be done prior to calibration. (see 5.19) Each calibration step in this procedure relies on the accuracy of the preceding step. Care should be taken to make each adjustment in the order in which it appears in this procedure.

5.3 This procedure combines the calibration adjustments for the Digitizing and Display portion with the Accessory portion. If desired, one portion, the Accessory Module for example, can be calibrated separately, provided that the other portion is known to be calibrated. Each adjustment is clearly marked as to be used for Digitizing and Display, Accessory, or Accessory Module 220 only.

5.4 EQUIPMENT

5.5 General. The following equipment is required for DMM calibration, and is listed in order of use. The specifications listed are the minimum required to make the adjustment, not the accuracy of the instrument mentioned. Equipment required for the calibration of the Digitizing and Display portion and the DC portion of the accessory module are listed below.

(a) Precision null detector/microvoltmeter with a minimum of 10 microvolts of resolution. For example, Fluke Model 845AR.

(b) Voltage calibrator variable from 0 to 1000 volts and a resolution better than 100 microvolts (at 1 and 10 volts). For example, Fluke Model 332A.

5.6 Model 220 Accessory Calibration. Equipment required for the calibration of the AC portion of the Model 220 Accessory Module is listed below.

(a) Laboratory power source (AC) variable from 0 to 500 volts and 50 to 100 kHz with a resolution better than 100 microvolts (at 1 and 10 volts). For example, Optimation AC 104.

(b) AC/DC laboratory transfer standard for calibration of the AC source. For example, Holt Model 6 Thermal Transfer Voltmeter.

5.7 TOOLS

(a) Insulated blade-type calibration tool.

(b) No. 1 Phillips screwdriver.

5.8 OTHER

(a) 100,000 ohm 1/4 watt, 5% carbon resistor.

(b) 51,000 ohm 1/4 watt, 5% carbon resistor.

(c) 2 megohm 1/4 watt, 5% carbon resistor.

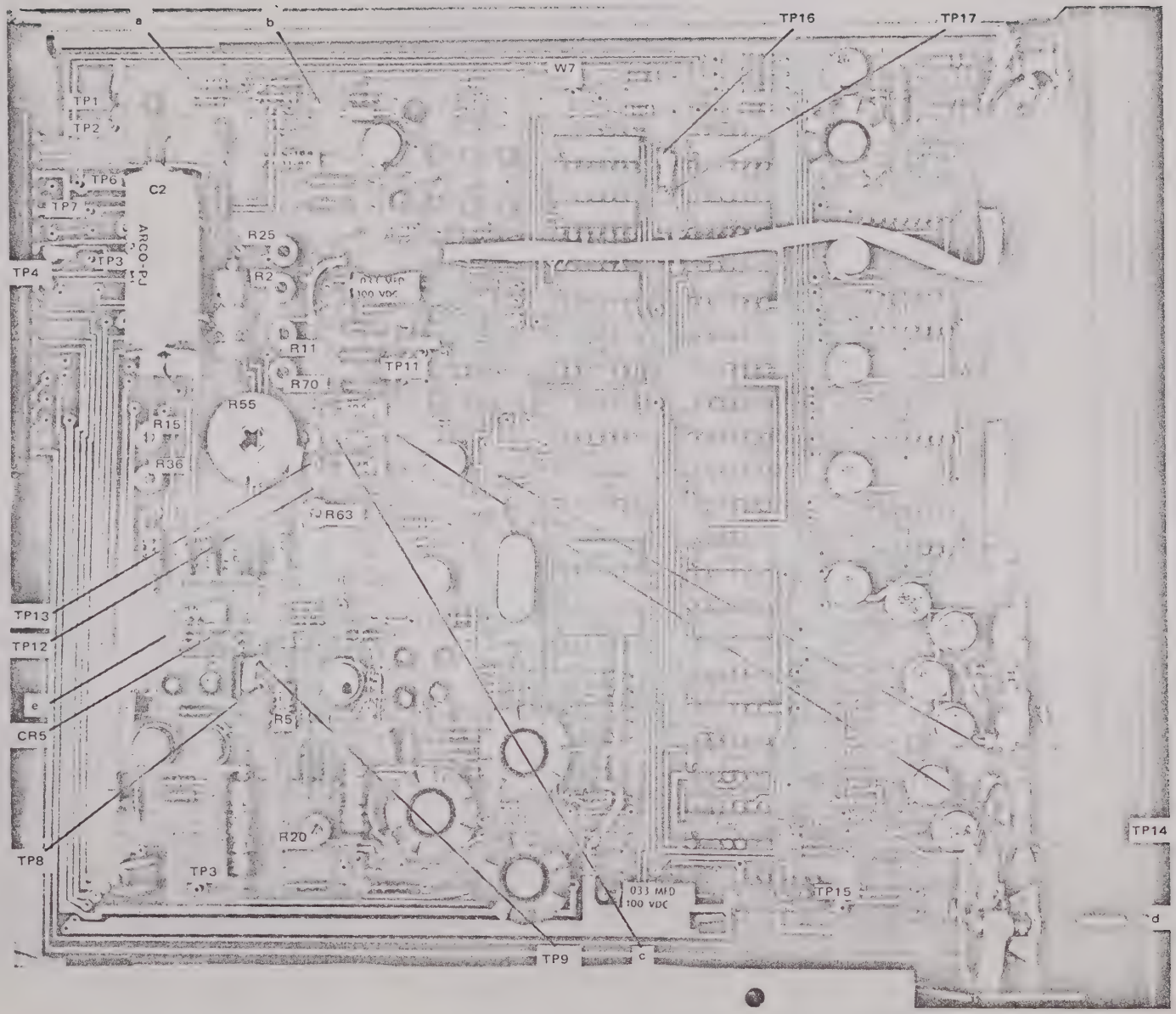


Figure 5.1 - Display (Readout) Module

5.9 PREPARATION

(a) Remove both the top and bottom covers of the DMM. Set the Model 4400 OFF-ON-HOLD switch to ON and allow at least 30 minutes for the instrument to warm up.

5.10 RAMP GENERATOR ZERO ADJUSTMENT (Display Module)

(a) Remove Isolator Module.

(b) Connect a jumper between TP4 (Ramp Input) and TP6 (Reference Common).

(c) Connect a 10K ohm resistor across capacitor C2.

(d) Connect a jumper from the junction of R13 and the base of Q3 (point "a" on figure 5.1.) to TP6.

(e) Connect the positive side of the precision calibrator source in series with a 2 megohm resistor to the junction of R33 and R34 (point "b"). Connect the low side of the source to TP6.

(f) Connect the positive input of the microvoltmeter in series with a 51K ohm isolation resistor to the same junction of R33 and R34. Connect the low side of TP6.

(g) Adjust the calibrator voltage for a reading of zero ± 30 microvolts.

(h) Connect the positive input of the microvoltmeter in series with the 51K ohm isolation resistor to the top of C2 (figure 5.1). Retain the low side at TP6.

(i) Adjust voltage zero control R25 for a reading of zero ± 30 microvolts.

(j) Move the microvoltmeter positive input to TP11.

(k) Adjust current zero control R11 for a reading of zero ± 30 microvolts.

(l) Verify results of steps f, h and j to establish optimum zeros.

(m) Do not remove jumpers or voltages until after paragraph 5.11.

5.11 NULL DETECTOR ZERO ADJUSTMENT (Display Module).

(a) Connect a jumper between TP1 and TP6.

(b) Attach another jumper from the junction of R56 and R57 (point "c") to TP6.

(c) With the low side of the microvoltmeter still attached to TP6, connect the positive input to the summing node junction of R57, R58 and R59 (point "d").

(d) Adjust the current zero potentiometer, R63, to read zero ± 30 microvolts.

(e) Remove the jumper from the junction of R56 and R57 to TP6.

(f) Remove all other jumpers, resistors and voltages.

(g) Reinstall Isolator Module.

5.12. INTERNAL REFERENCE ADJUSTMENT (Display Module)

(a) Set the Voltage Calibrator to the reference voltage value recorded on the zener serial tag mounted on the back of the display shield.

(b) As shown in figure 5.3, connect the positive side of the voltage source to the cathode side of CR5 (point "e") and the positive input of the microvoltmeter to TP7. CAUTION: Avoid shorting cathode of CR5 to adjacent straps.

(c) Connect the negative side of the calibrator to the low side of the microvoltmeter and tie their case connections together.

(d) Adjust the zener calibration potentiometer R36 for a microvoltmeter reading of zero ± 10 microvolts.

(e) Remove the leads to CR5 and TP7.

5.13 DC ISOLATOR ZERO ADJUSTMENT.

(a) Allow adequate warm-up time if isolator plug-in has just been reinstalled into DMM.

(b) On the display board, connect the microvoltmeter input lead to TP2 and the low side to the input common terminal of the accessory module (white). Connect a jumper between the + input (red) and input common (white) terminals of the accessory module. (Be sure the DMM is in DC and in the 10 volt range).

(c) Remove the power to the DMM and adjust the front-panel zero control R22 to its mechanical center. Open the accessory drawer. Connect a jumper across R5 (100K, 1% resistor) and replace the accessory drawer.

(d) Apply power and adjust the voltage zero control R19 for a microvoltmeter reading of zero ± 100 microvolts.

(e) Select the 1000 volt range.

(f) Adjust current zero control R31 for a microvoltmeter reading of zero ± 100 microvolts.

(g) Remove power from the DMM and open the accessory drawer. Remove the microvoltmeter leads and the jumper across R5. Replace the accessory drawer and reapply power. Remove jumper from across DMM input.

5.14 DMM POLARITY ADJUSTMENT (Display Module)

(a) Select the 10 volt range. Connect the DMM input terminals to a DC voltage source and set the voltage source output to −.002 volts.

(b) Adjust the null detector voltage zero control R70 for a display reading bouncing between −0.001 and −0.002 volts.

(c) Set input to +0.002 volts. Adjust R20 (voltage zero control for the auto polarity) for a display reading bouncing between 0.001 and 0.002 volts.

5.15 POSITIVE AND NEGATIVE GAIN ADJUSTMENT (Display Module)

(a) Set the calibrate control R1 on the front panel to its mechanical center.

(b) Set the voltage source output to −9.9990 volts.

(c) Adjust the rough calibration control R2 for a DMM display reading of 9.9 volts. Adjust R1 for a display reading bouncing between −9.998 and −9.999.

(d) Reverse the polarity of the voltage source (+9.9990).

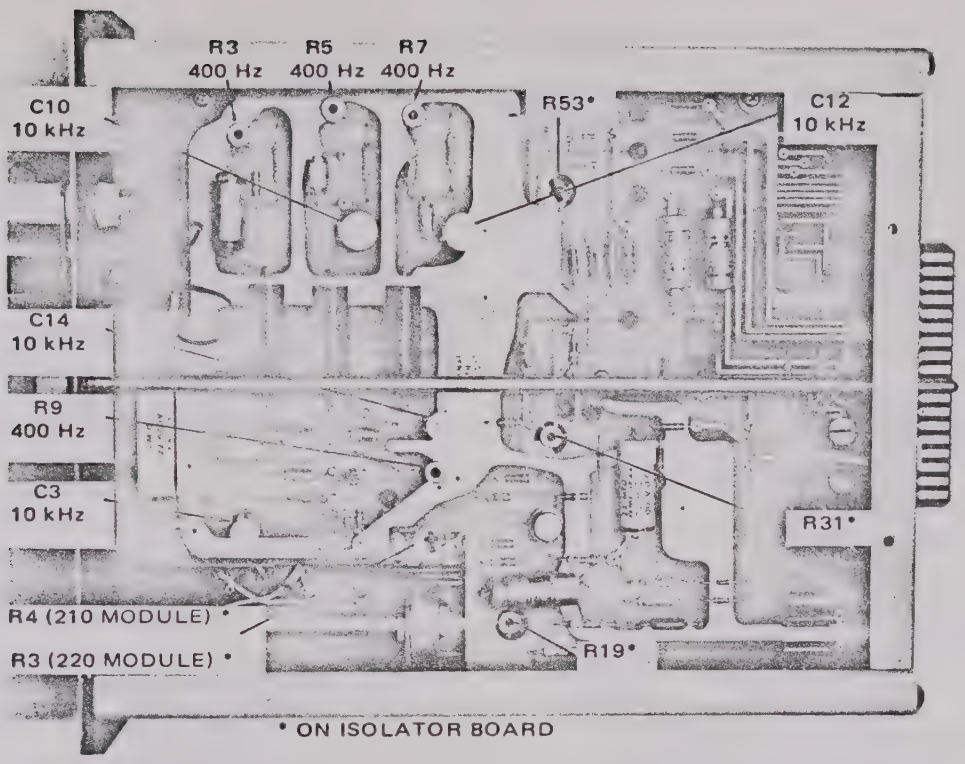


Figure 5.2 - Locations, AC Converter (Bottom View)

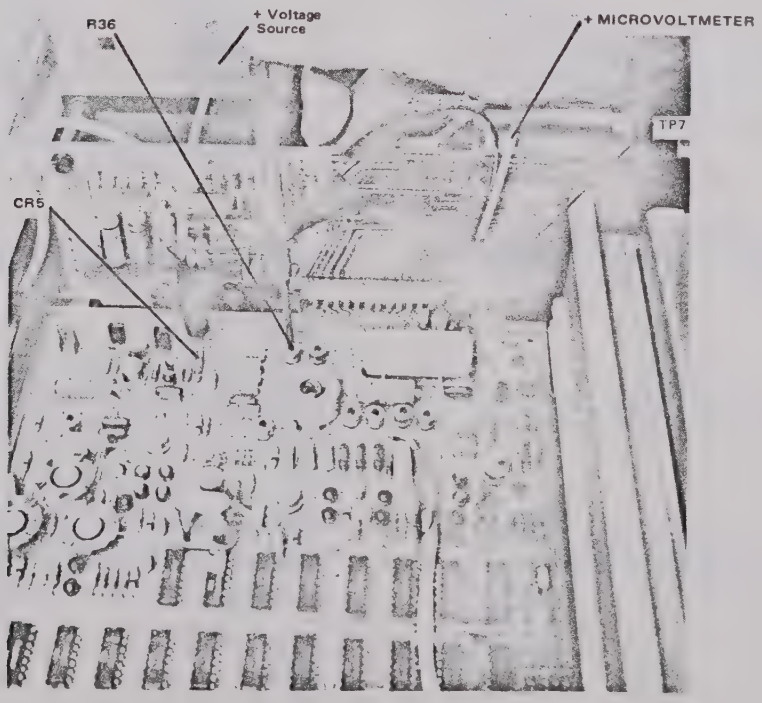


Figure 5.3 - Test Setup - Reference Calibration

(e) Adjust the positive polarity gain control R55 for a display reading bouncing between 9.998 and 9.999 volts.

(f) Check steps a through e for interaction between controls. Repeat adjustment if necessary.

5.16 VOLTAGE DIVIDER ADJUSTMENT (Accessory Module)

(a) Set the voltage source output to −1.0000 volts and range to 1.

(b) Adjust Isolator gain control R53 for a display reading of −1.0000.

(c) Select a DMM range of 1000.

(d) Set the voltage source to −1000.00 volts.

(e) Adjust voltage divider control R4 (R3 on 220) for a DMM display reading of −1000.0.

(f) Set the voltage source to −1 volt and remove the supply from the input terminals.

5.17 CALIBRATE TEST ADJUSTMENT (Display Module)

(a) Select a DMM range of 1.

(b) Manually depress and hold in the calibration switch.

(c) Adjust R15 for a display reading of −1.0000.

5.18 AC VOLTAGE DIVIDER ADJUSTMENT (Accessory Module 220)

(a) Connect DMM input terminals to the AC voltage source.

(b) Select AC function and autorange.

(c) Set AC source output to 125.00 volts at 400 Hz.

(d) Adjust the 1000 volt, 400 Hz control (R3) for a DMM display reading of 0125.0 volts.

(e) Set AC source to 125.00 volts at 10 kHz.

(f) Adjust the AC input, 10 kHz control (C3) for a DMM display reading of 125.0.

(g) Set the AC source to the following series of AC voltages and adjust the appropriate controls as called out on the bottom plate of the Accessory Module. (See figure 5.2).

VOLTS RMS	FREQUENCY	ADJUST
0.90000	400 Hz	R9
0.90000	10 kHz	C14
9.0000	400 Hz	R7
9.0000	10 kHz	C12
90.000	400 Hz	R5
90.000	10 kHz	C10

5.19 TROUBLESHOOTING

5.20 General. The following procedure is designed to aid in isolating the cause of instrument malfunction down to the component level.

5.21 In the procedure, a series of checks are made along with the normal response of a properly operating DMM. If the instrument fails to operate as described, refer to the figure or paragraph indicated to the right of the response in paragraph 5.22.

5.22 FUNCTIONAL CHECK	NORMAL OPERATION	Ref. Figure
(a) Select DC and the 1 volt range. Connect a jumper between the input (red) and common (white) binding posts of the DMM. Select ON.	1. Polarity indicator lights 2. Readout lights 3. Readout displays all zeros (with front panel zero adjust.)	5.4 5.5 5.6
(b) Remove the jumper across the DMM inputs. Connect the DMM to a -1.5 volt source.	1. Polarity indicator reads minus. 2. Readout displays 12000. 3. Overrange (OL) indicator lights.	5.8 5.9 5.11
(c) Select 10 volt range.	1. Readout displays approximately -01.500.	5.12
(d) Reverse the polarity of the input to plus 1.5 volts.	1. Readout displays approximately +01.500	5.13
(e) Reduce input source to 0.9 volts and select 1 volt range.	1. Readout displays approximately +0.9000	5.14
(f) Select the 10, 100 and 1000 ranges.	1. Note that the readout changes as follows: +00.900, +000.90 and +0000.9.	5.15
(g) Select auto range and connect the DMM input to a +150 volt source.	1. DMM upranges to the 1000 volt range. 2. DMM stops at each range for approximately 0.5 seconds.	5.16 5.18
(h) Remove DMM input from the +150 volt supply and short DMM input leads together.	1. DMM downranges to the 1 volt range.	5.19
		Ref. Paragraph
(i) DEPRESS and hold in the CALIBRATE switch.	1. Readout displays -1.0000	5.41
220 MODULE ONLY		
(j) Select AC and the 1 volt range. Connect the DMM input leads to a 1 volt rms, 300 Hz source.	1. Readout displays input voltage.	5.42
(k) Select the 10, 100 and 1000 volt ranges.	1. Note that the readout changes as follows: 01.000, 001.00 and 0001.0.	5.43

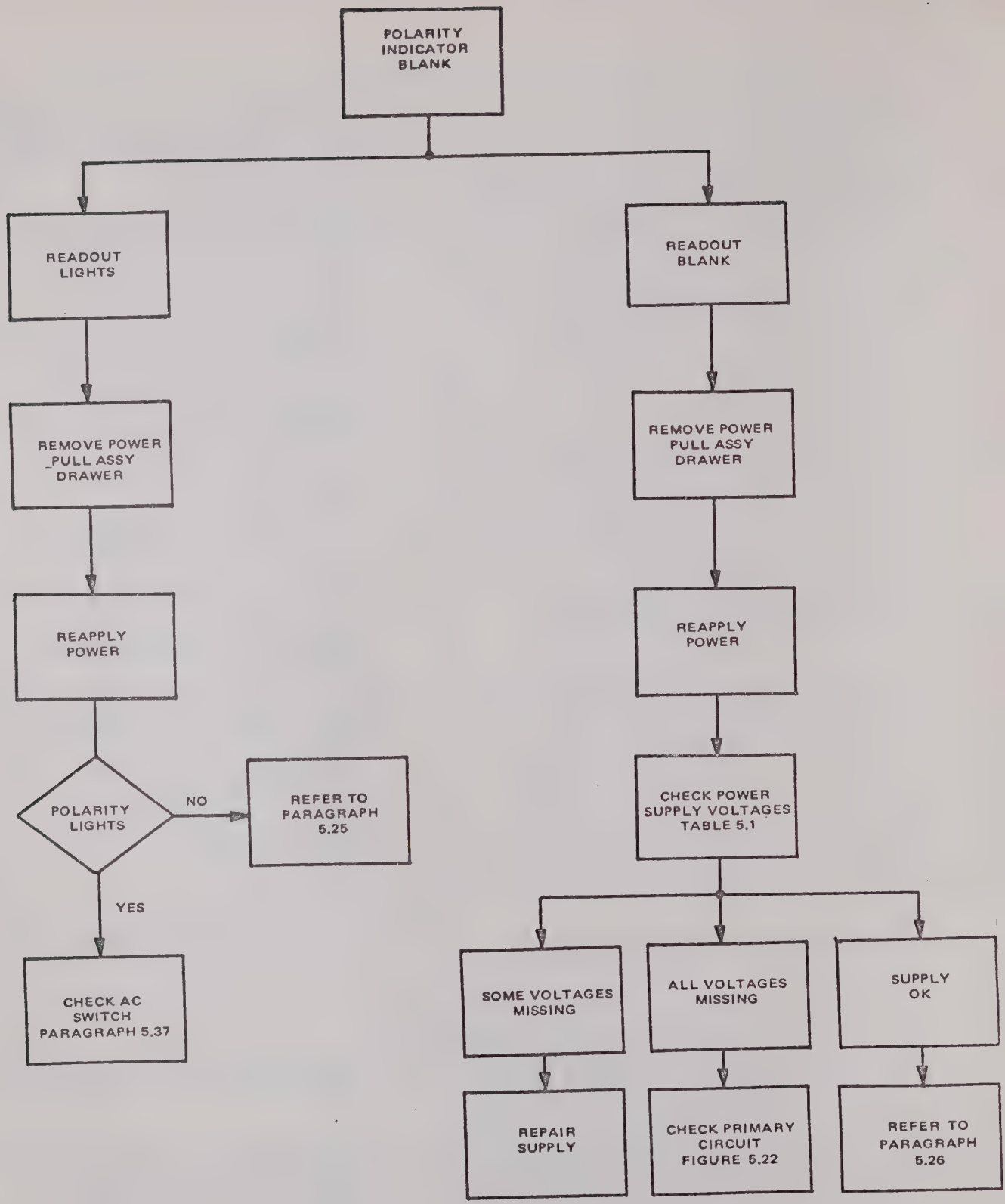
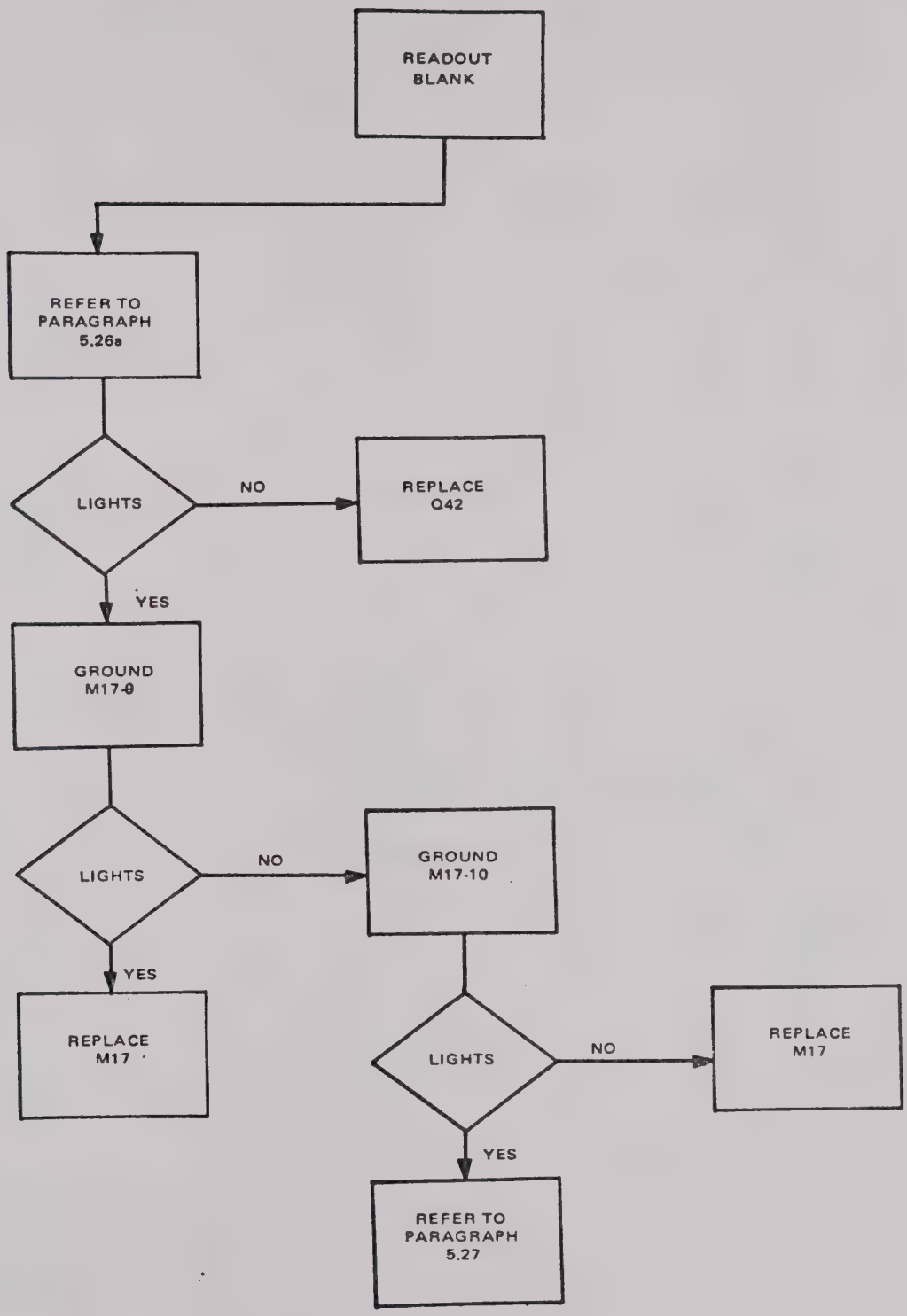
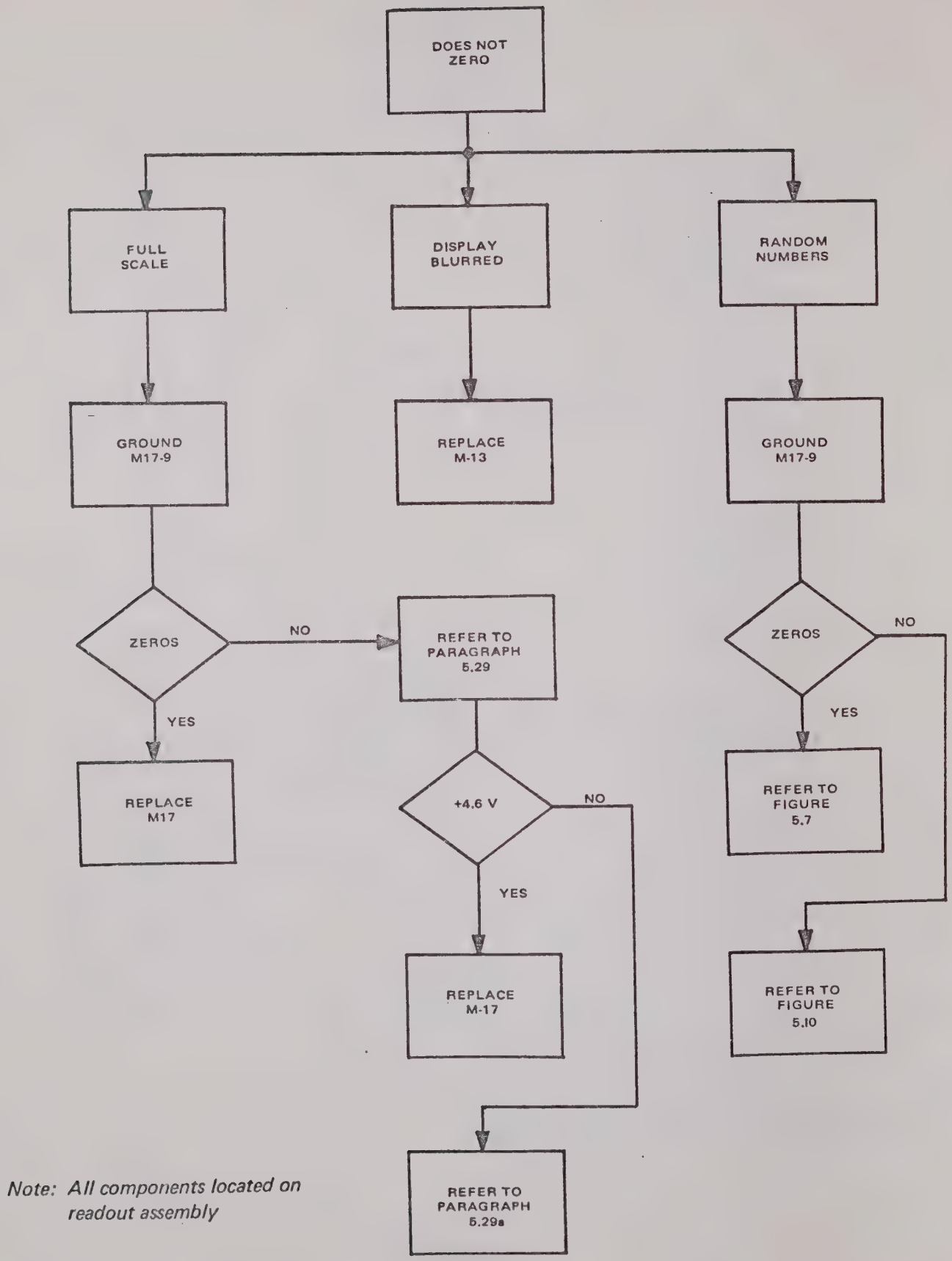

POLARITY INDICATOR BLANK
READOUT LIGHTS
REMOVE POWER PULL ASSY DRAWER
REAPPLY POWER
POLARITY LIGHTS
NO
REFER TO PARAGRAPH 5.25
YES
CHECK AC SWITCH PARAGRAPH 5.37
READOUT BLANK
REMOVE POWER PULL ASSY DRAWER
REAPPLY POWER
CHECK POWER SUPPLY VOLTAGES TABLE 5.1
SOME VOLTAGES MISSING
ALL VOLTAGES MISSING
SUPPLY OK
REPAIR SUPPLY
CHECK PRIMARY CIRCUIT FIGURE 5.22
REFER TO PARAGRAPH 5.26

Figure 5.4



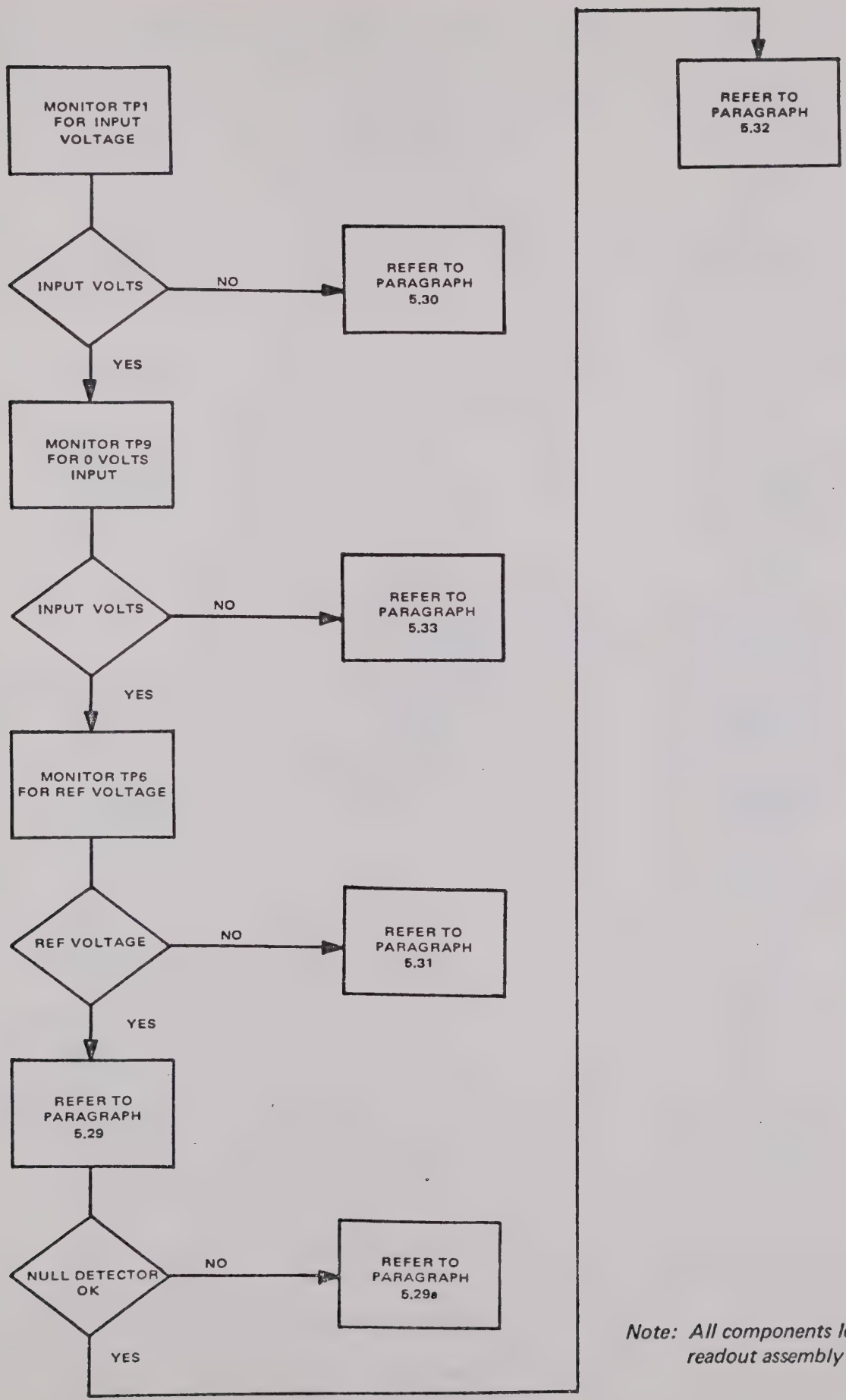
Note: All components located on readout assembly

Figure 5.5



Note: All components located on readout assembly

Figure 5.6



Note: All components located on readout assembly

Figure 5.7

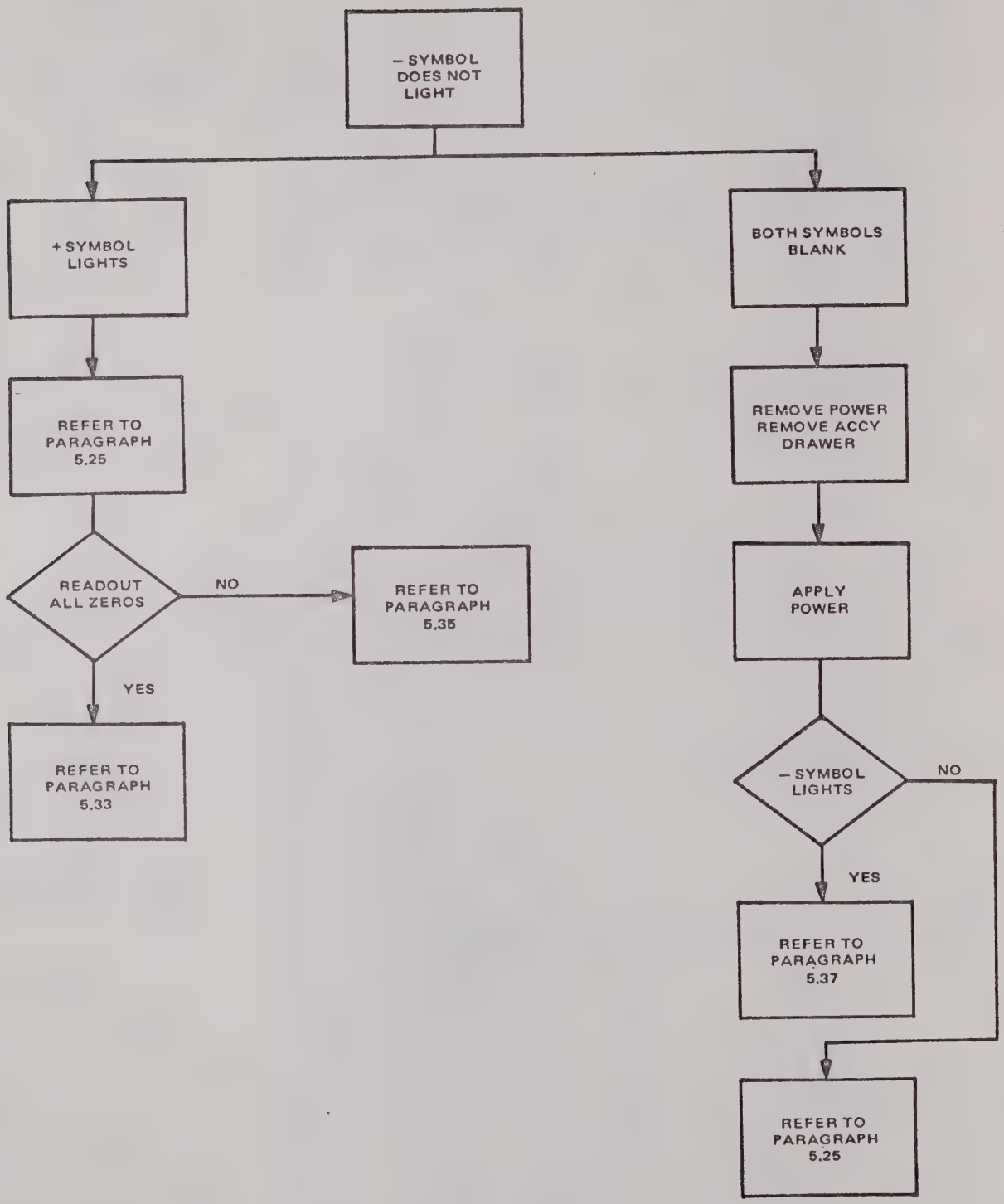
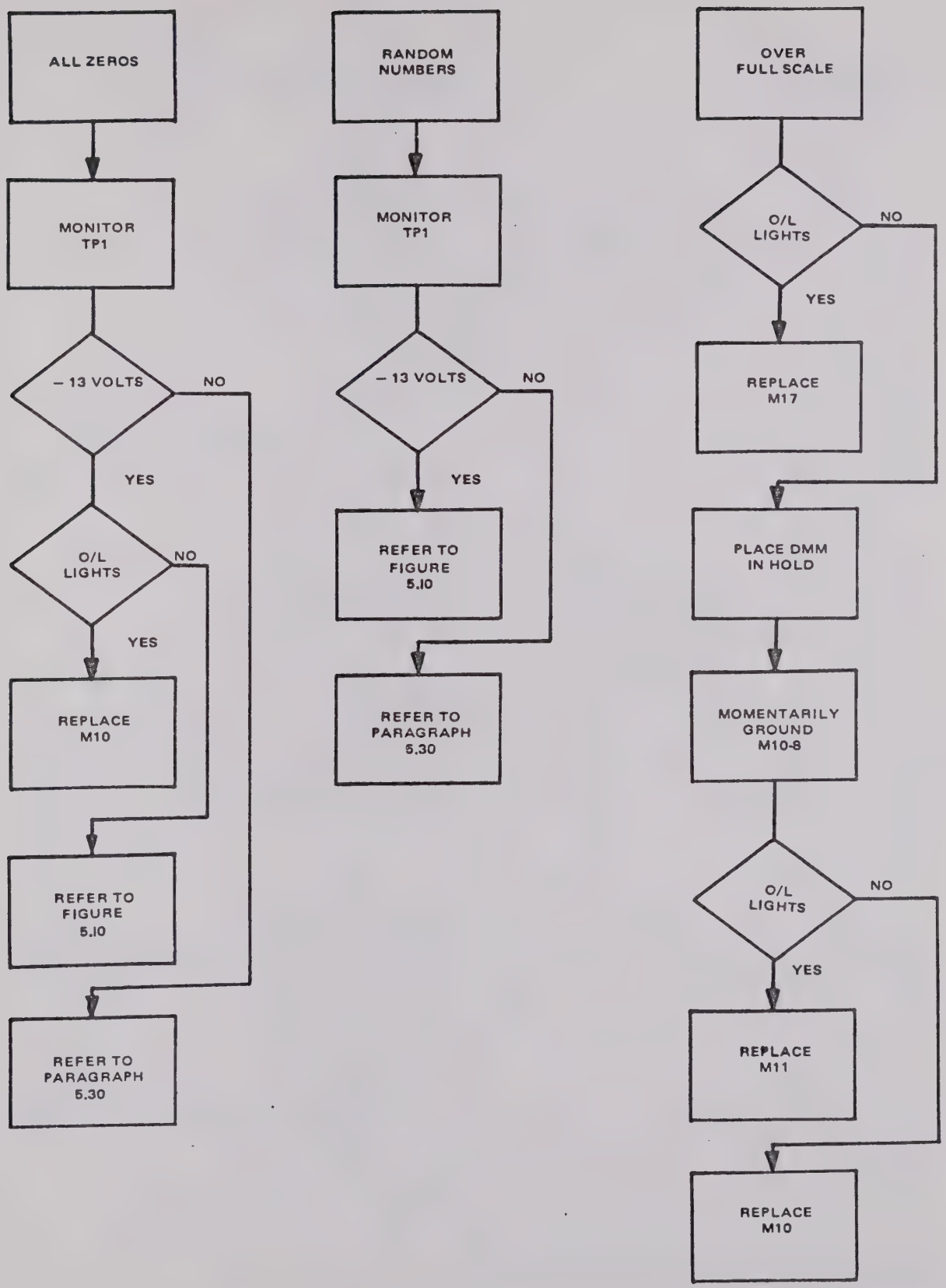
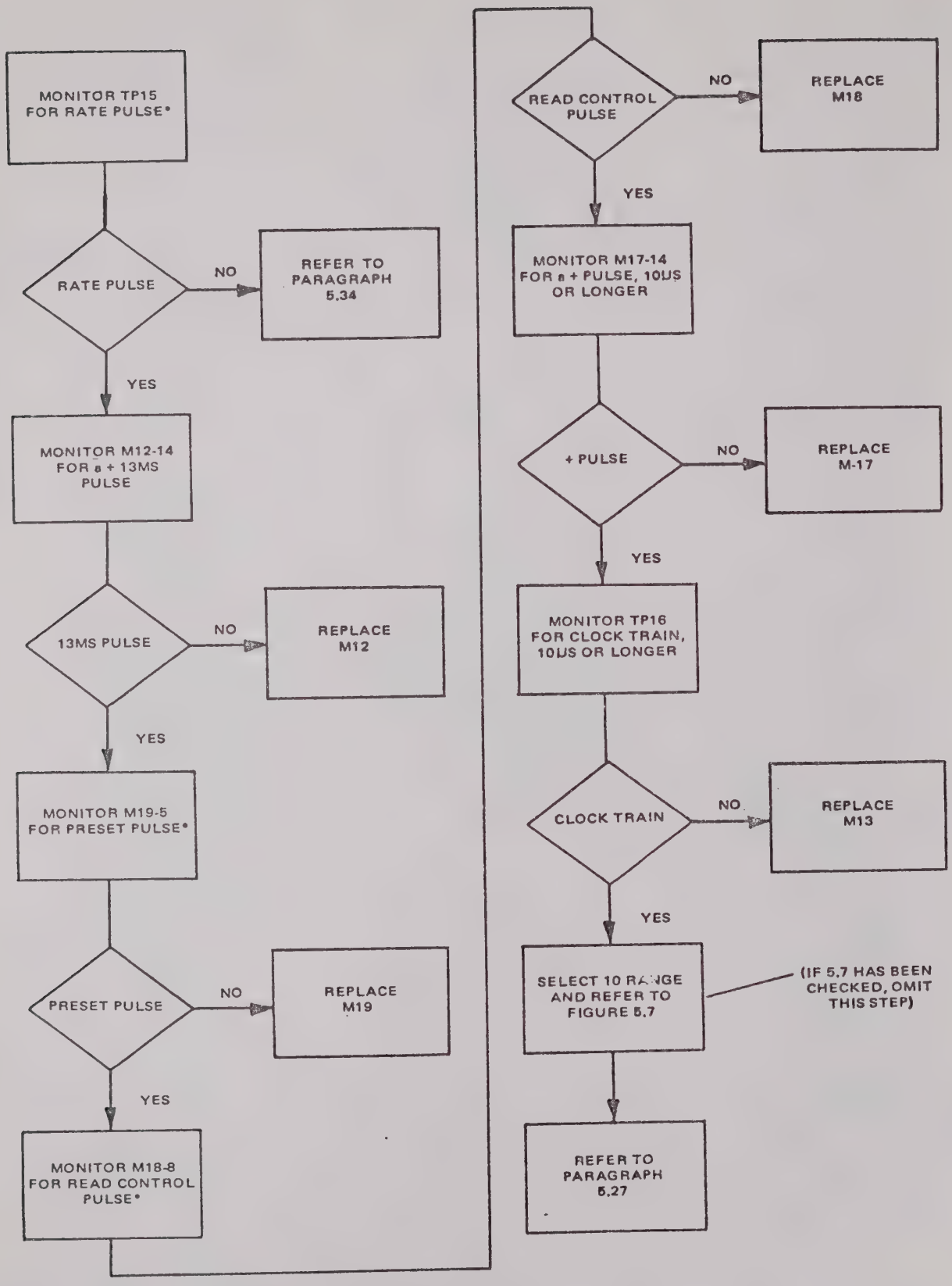

– SYMBOL DOES NOT LIGHT
+ SYMBOL LIGHTS
REFER TO PARAGRAPH 5.25
READOUT ALL ZEROS
NO
REFER TO PARAGRAPH 5.35
YES
REFER TO PARAGRAPH 5.33
BOTH SYMBOLS BLANK
REMOVE POWER REMOVE ACCY DRAWER
APPLY POWER
– SYMBOL LIGHTS
NO
YES
REFER TO PARAGRAPH 5.37
REFER TO PARAGRAPH 5.25

Figure 5.8



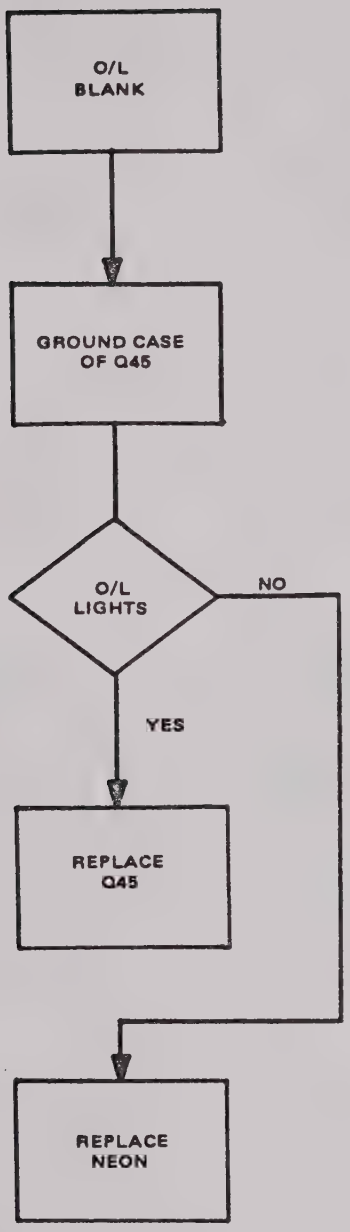
Note: All components located on readout assembly

Figure 5.9



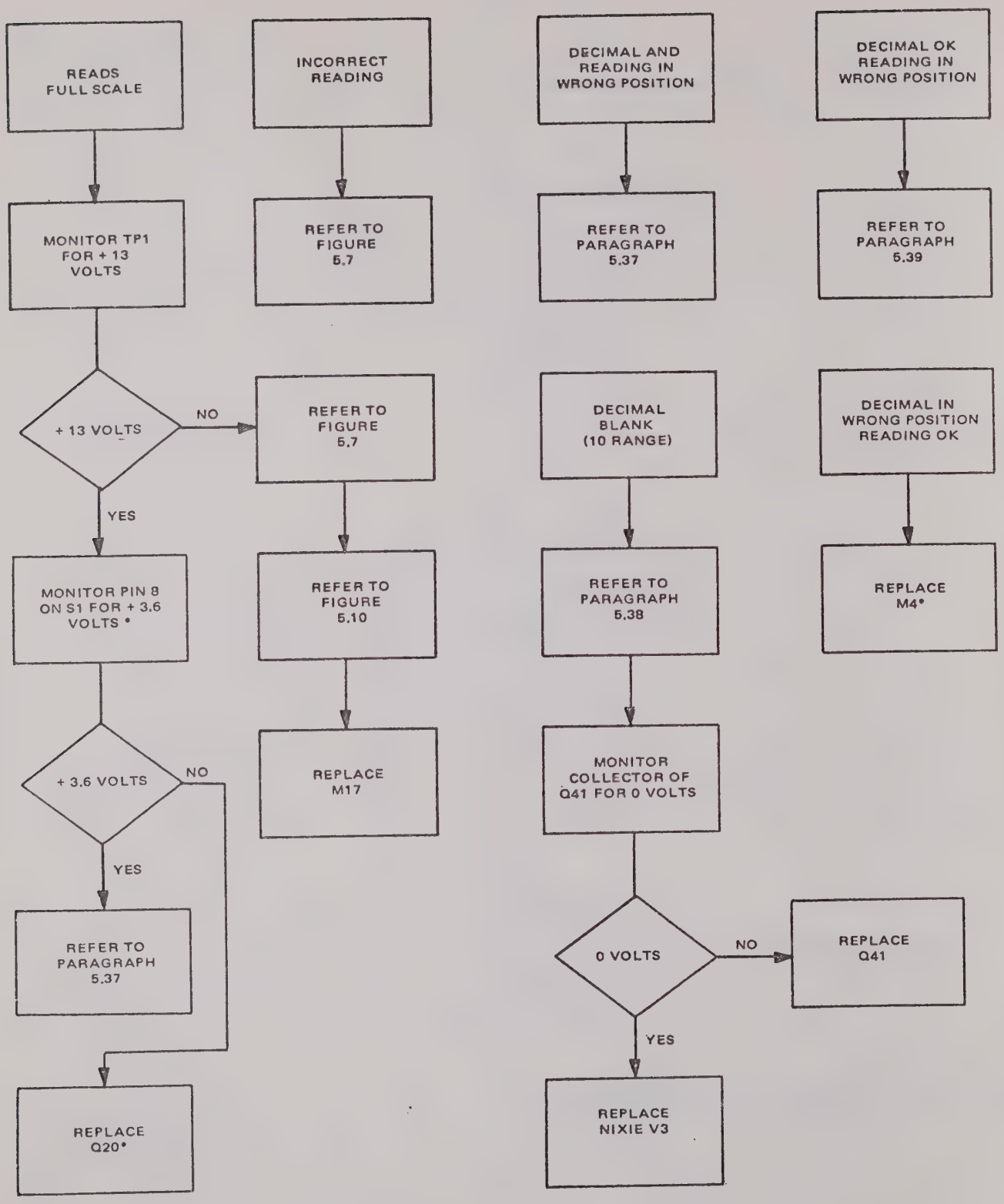
Note: All components located on readout assembly
**Pulse forms are shown in figure 5.21*

Figure 5.10



Note: All components located on readout assembly

Figure 5.11



• ON ACCESSORY BOARD, ALL OTHER COMPONENTS LOCATED ON READOUT ASSEMBLY

Figure 5.12

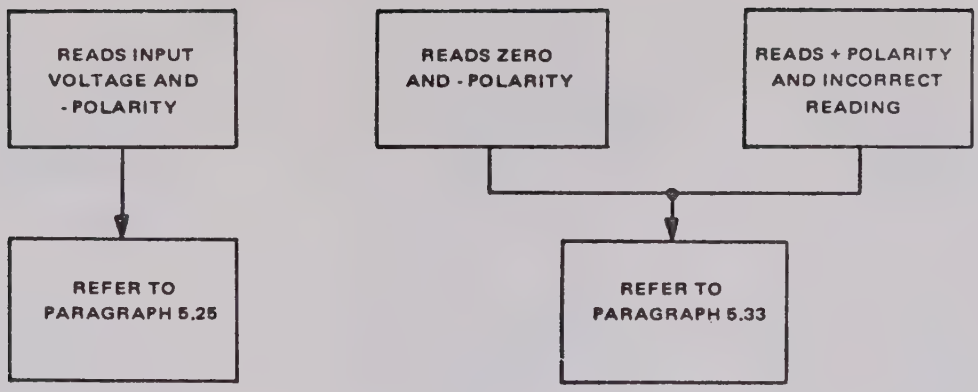
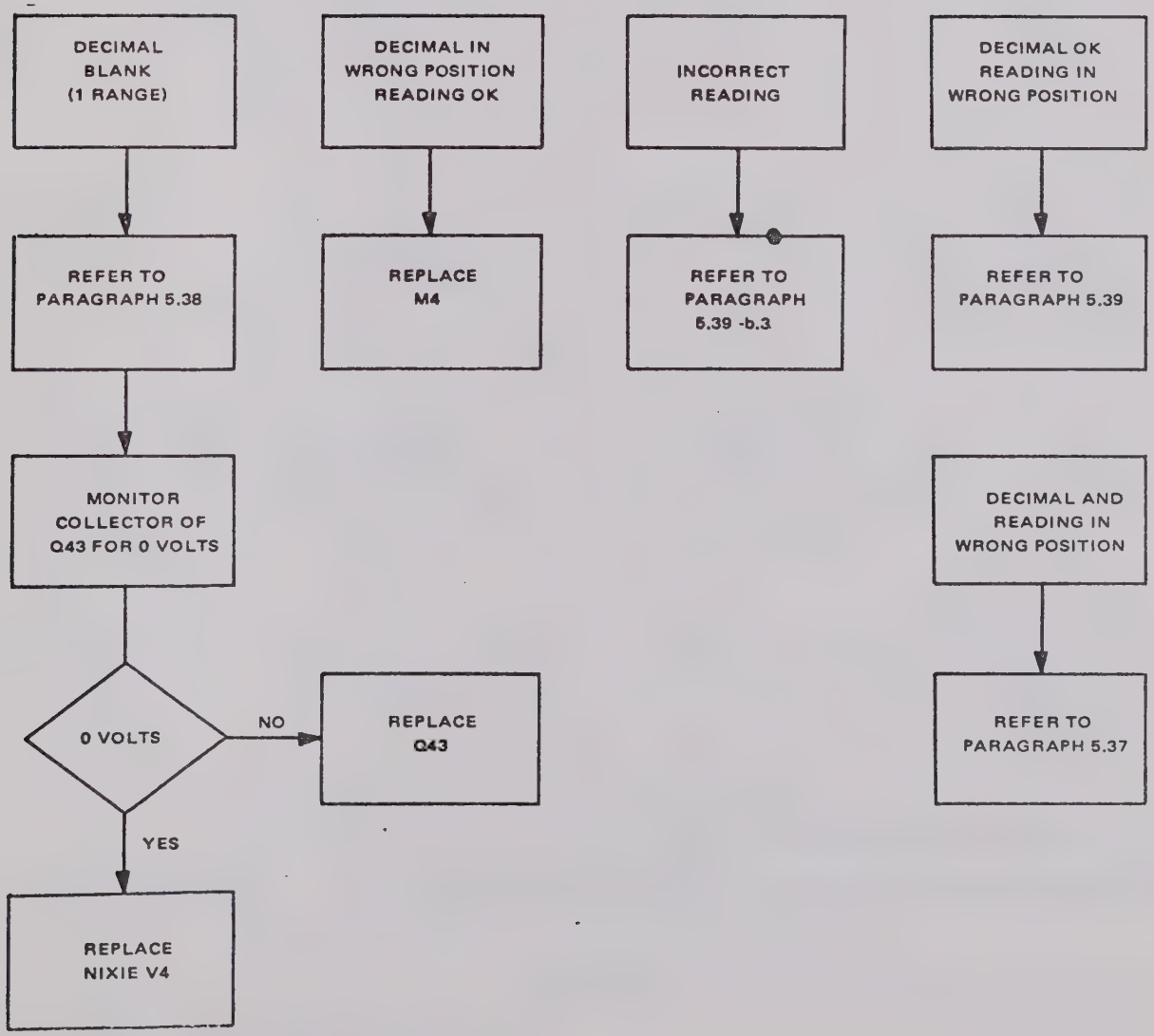
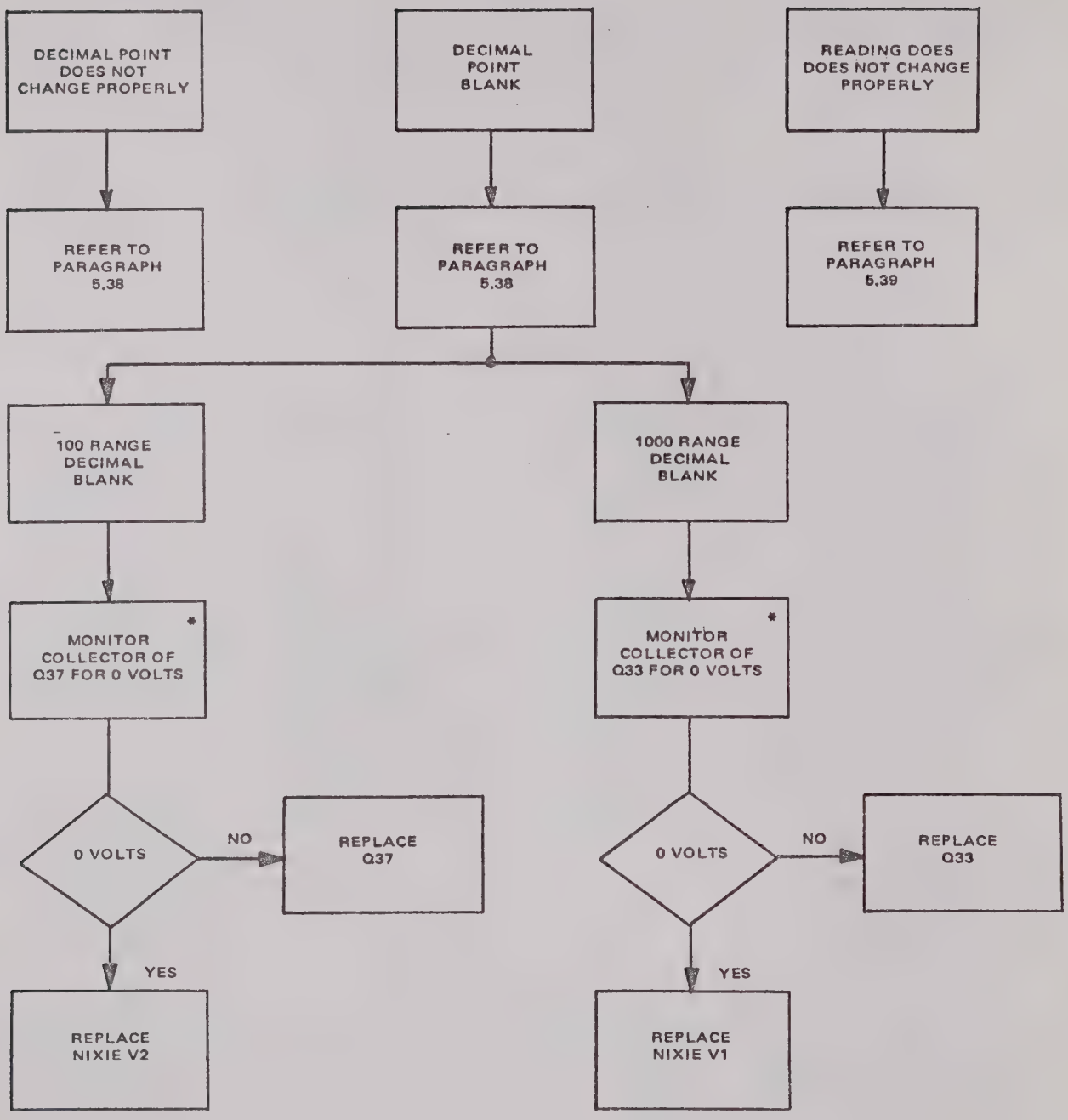

READS INPUT VOLTAGE AND - POLARITY
REFER TO PARAGRAPH 5.25
READS ZERO AND - POLARITY
READS + POLARITY AND INCORRECT READING
REFER TO PARAGRAPH 5.33

Figure 5.13



Note: All components located on readout assembly

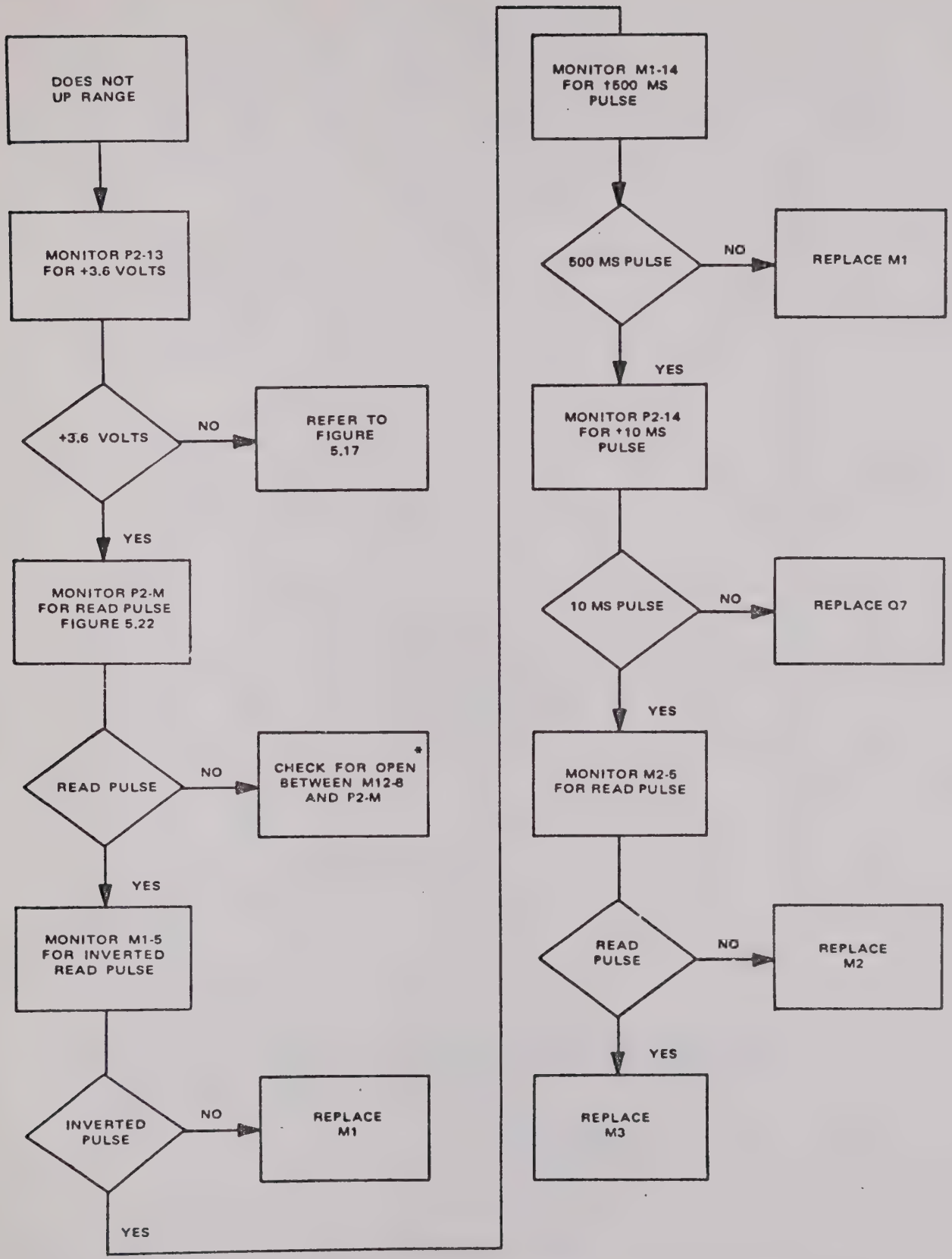
Figure 5.14



Note: All components located on readout assembly

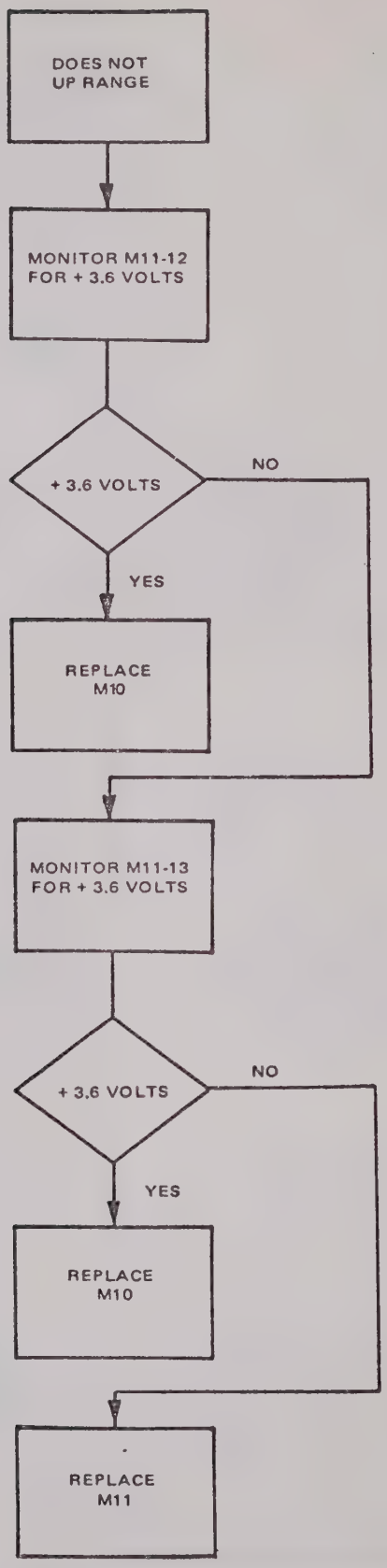
**CAUTION: Voltage may reach +60 volts or greater if component is bad*

Figure 5.15



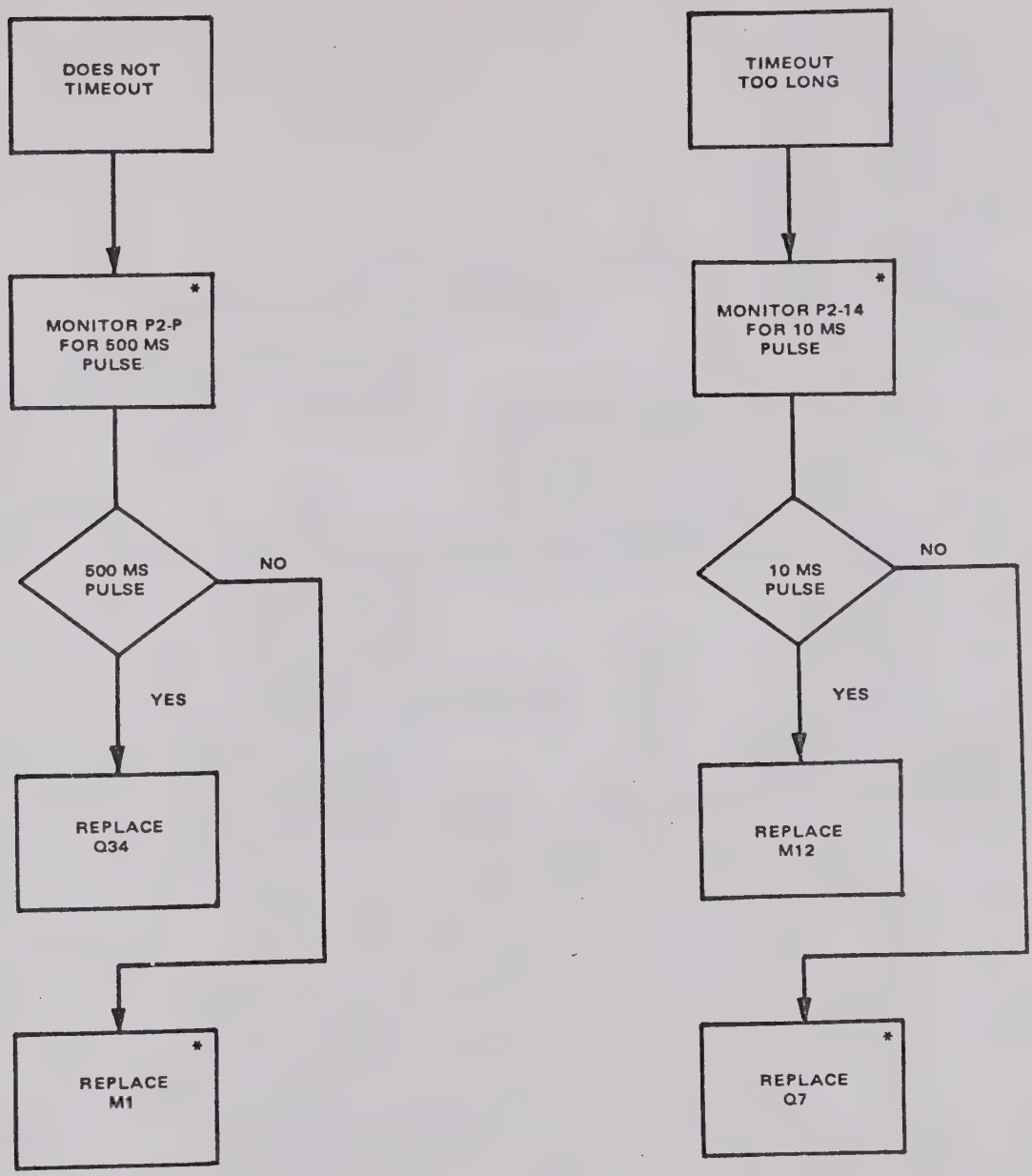
* *Located on readout board; all other components are located on the accessory module*

Figure 5.16



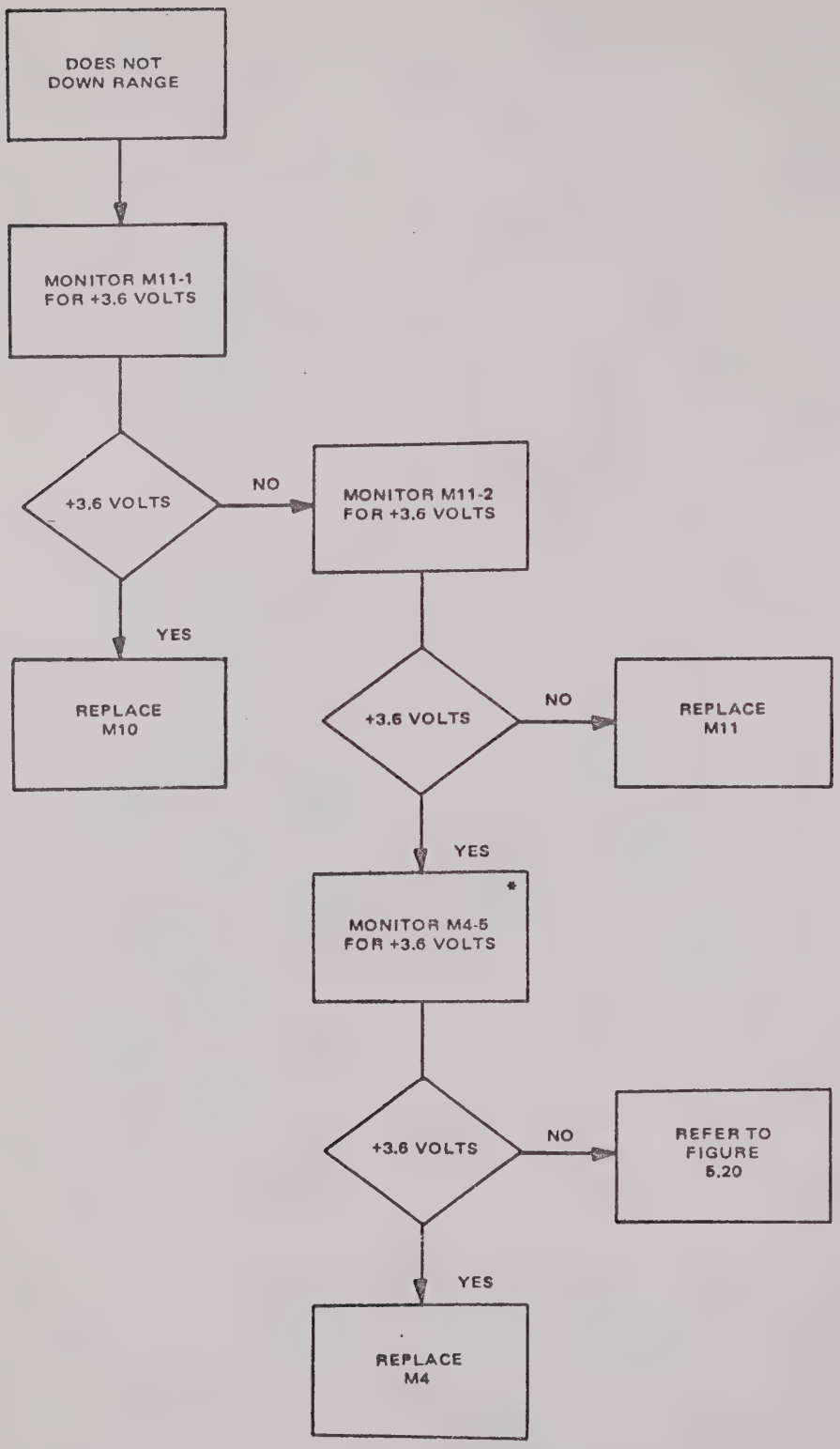
Note: All components located on readout assembly

Figure 5.17



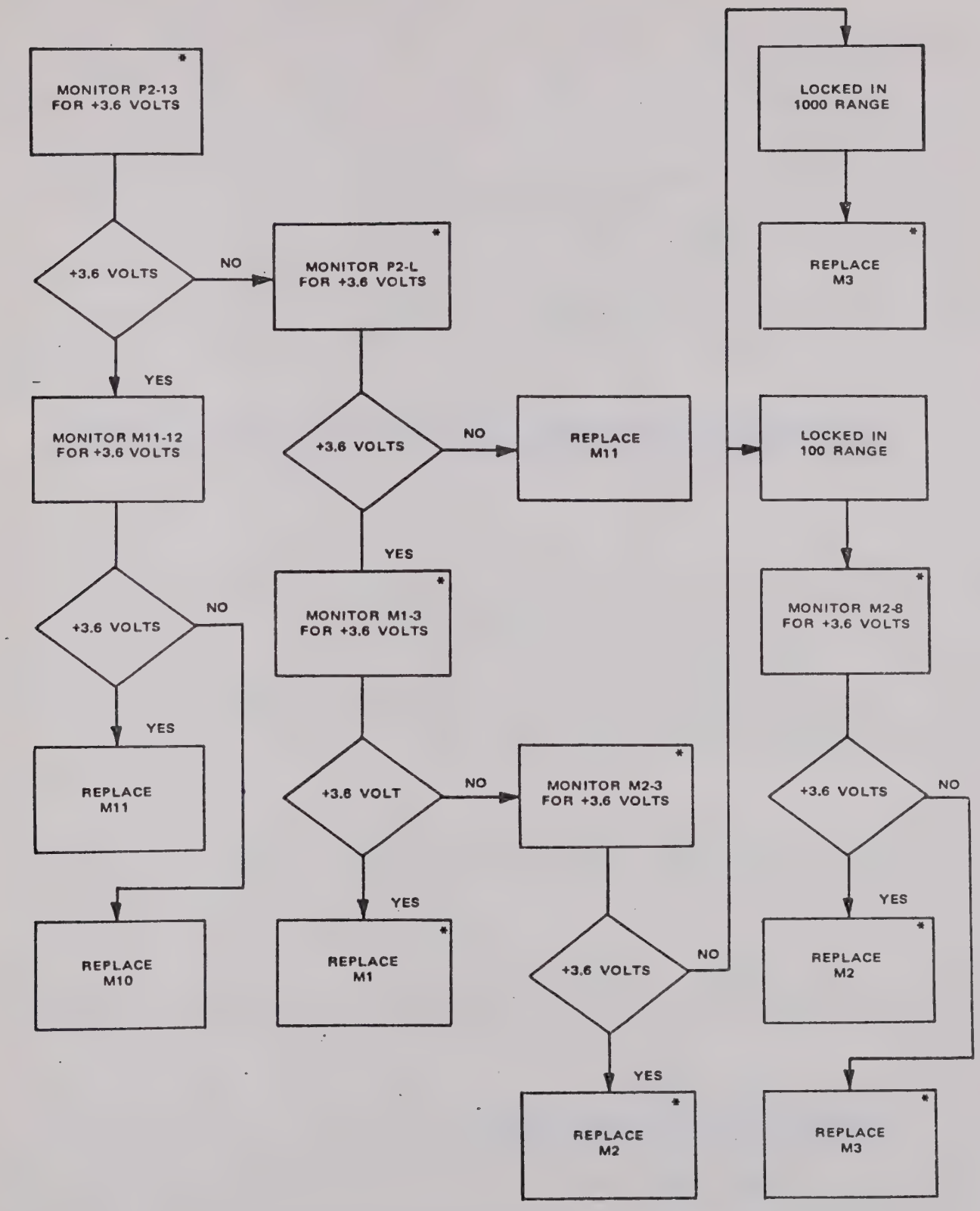
*Located on accessory module; all other components located on readout assembly

Figure 5.18



*Located on accessory board; all other components located on readout assembly

Figure 5.19



* *Located on accessory board; all other components located on readout assembly*

Figure 5.20

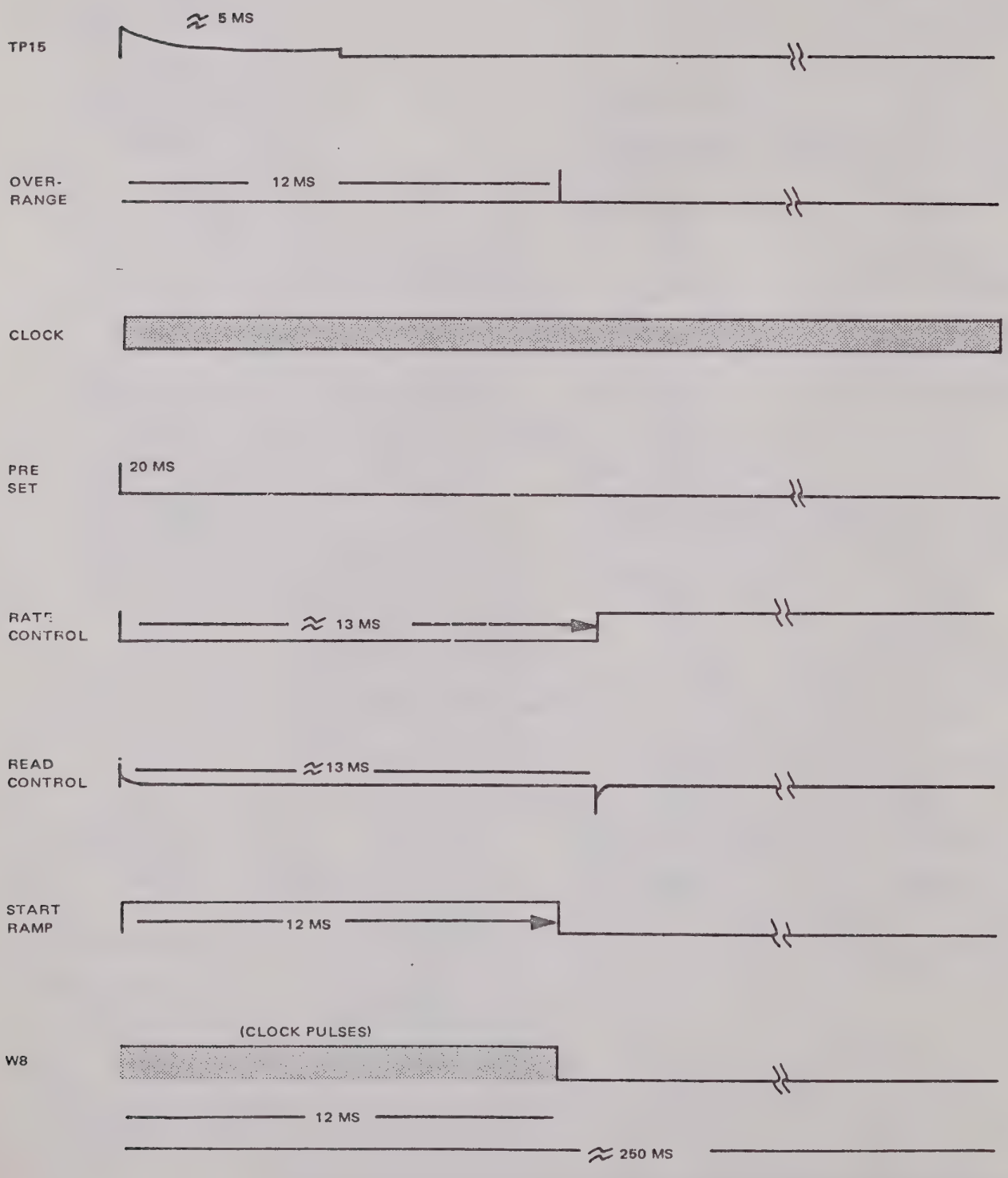


Figure 5.21 Timing Diagram

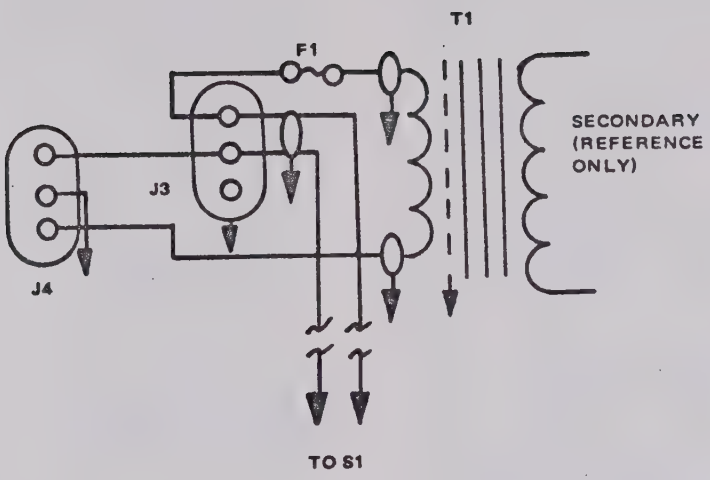


Figure 5.22 Primary Circuit

5.23 REPAIR

5.24 Power Supply. A convenient place to check power supply levels is on connector J2, the accessory drawer jack. Remove power from the DMM, remove the accessory drawer and both the top and bottom covers of the DMM. All values (of Table 5.1) are approximate and are referenced to pin 17 of J2.

Table 5.1. Power Supply Voltage

PIN NO. J2	VOLTAGE
18	+300
V	+150
T	+ 28
S	+ 18
U	+ 3.6
15	- 18
16	- 28
17	Digital Common

If all voltages are missing, check the primary circuit (figure 5.22). With the power cable removed and the OFF/READ/HOLD switch set to either ON or HOLD, a resistance of approximately 15 ohms should be read across terminals 1 and 3 of J4.

5.25 Polarity Drive. With power applied to the DMM, simultaneously connect pins 1 and 3 of M9 to digital common. Verify that the polarity indicator alternately reads + and -, changing with each read pulse (figure 5.25).

5.25.a - Polarity is Blank. Short the collector of Q39 to digital common.

1. - polarity symbol lights. Replace Q39.

2. - polarity symbol does not light. Replace neon.

5.25.b + Polarity is Blank. Short the collector of Q40 to digital common.

1. + polarity symbol lights. Check Q38 and Q40.

2. + polarity symbol does not light. Replace neon.

5.25.c Does not Alternate. Monitor TP15 and verify a repetition rate pulse (figure 5.21).

1. 5 ms pulse. Replace M9.

2. Pulse missing. Refer to paragraph 5.34.

5.25.d Both Symbols Remain On. Connect pins 13 and 14 of M9 to digital common.

1. - polarity remains lit. Replace Q39.

2. + polarity remains lit. Replace Q40.

5.26 Blanking. The blanking circuit consists of transistor Q42, which controls the level of the anode supply voltage to the display tubes. When conducting, Q42 lowers the supply voltage below the point where the display tubes can operate. When Q42 is off, the display tubes operate normally (figure 5.25).

5.26.a Inhibit Blanking. To inhibit the blanking circuit and permit normal instrument operation, connect a jumper from digital common to the right side resistor R102 (as viewed in figure 5.25).

5.26.b To inhibit the DMM for a counter check (paragraph 5.27), connect a jumper from digital common to the left side of R102 (figure 5.25). Place DMM in Hold.

5.27 Counter. The counter tallies the number of clock pulses it receives from the counter control circuit and consists of four decade counters and an overrange flip-flop, all connected in tandem. The failure of a component does not affect the operation of the counter until the decade containing the faulty part is required to count. Therefore, when the counter fails to count past a particular number, the component responsible for producing the next number or series of numbers is at fault (figure 5.24).

5.27.a Counter Check. The counter can be checked by testing the ability of each decade to count from 0 through 9. The decades are made to count by toggling (alternately grounding the Q and $\overline{Q}$ outputs) the A1 flip-flops. Shown in figure 4.17 is the toggling sequence and the display tube involved for each decade. Before proceeding with the counter check, the DMM must be set up as described in paragraph 5.26.b.

5.27.b Toggling. Shown in Table 5.2 is the sequence for checking the operation of the counter. Listed under each flip-flop designator (M1, M3, M5 and M7) are the pins which are gounded to cause the counter to count (pins 13 and 14). The check starts by grounding pin 14 of M1 as indicated by the X beneath the number 14 of M1. To the left of the X is the figure 1, indicating the number appearing in the readout window when pin 14 is grounded. The second step is the grounding of pin 13 of M1 to produce a readout of 1. This procedure of alternately grounding pins 14 and 13 is continued until each decade is checked. Note that M1 is checked twice. The reason being that the precount circuit (see paragraph 4.34) prohibits the generation of a 10 (a 1 of the M3 flip-flop) during the first M1 check.

Table 5.2. Toggling Sequence

DISPLAY READS	M1		M1		M3		M5		M7	
	13	14	13	14	13	14	13	14	13	14
0										
1		X		X						
2	X		X		X		X		X	
3		X		X		X		X		X
4	X		X		X		X		X	
5		X		X		X		X		X
6	X		X		X		X		X	
7		X		X		X		X		X
8	X		X		X		X		X	
9		X		X		X		X		X
10	X		X		X		X		X	

5.28 Counter Failure. Listed below are the most common symptoms and causes.

5.28.a Blank Number. A blank number is caused by either the display tube or the display driver. Check the tube for normal operation by grounding the pin of the driver corresponding to the blank number (see Table 5.3). If the display tube fails to light, replace tube. If the display tube does light, replace the display driver.

Table 5.3. Display Driver Outputs

DISPLAY DRIVER PIN NO.	9	5	10	4	11	3	12	2	13	1
DISPLAY NUMBER	0	1	2	3	4	5	6	7	8	9

5.28.b Double Number. A double number is the result of either a short in the tube or in the display driver. Swap the tube with the double number with a tube in an adjacent socket.

(a) Double number appears in new tube. Replace driver.

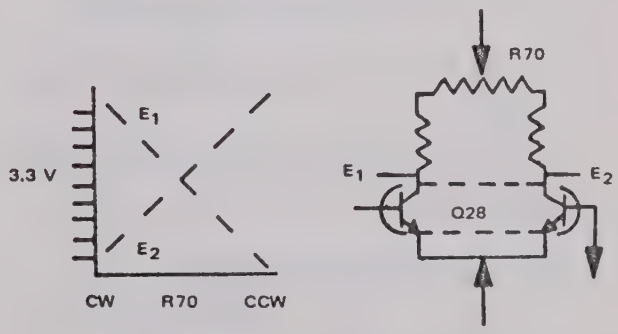
(b) No double number. Replace original tube.

5.28.c Counter Stops. A halt in the counter during toggling is caused by either a faulty decade flip-flop or faulty NOR gate. Refer to figure 4.17 and determine which component fails to perform the required sequence.

5.28.d Counter Skips. The counter may skip one or more numbers during the toggling sequence due to a faulty component. See figure 4.17.

5.29 Null Detector Check. Connect a jumper across CR13 and connect a multimeter across input common (white) and M17-6 (+ lead to M17-5). Adjust null detector potentiometer fully clockwise and verify a reading of approximately zero volts. Adjust R70 fully counterclockwise and verify a reading of approximately +4.6 volts. Remove jumper and meter leads. (figure 5.30)

5.29.a Null Detector Repair. Connect a precision voltmeter common lead to TP6 and the input lead to a 10K isolation resistor. Monitor each collector of Q25 individually while adjusting R70 and verify the voltage change as shown below.



(Crossover Approximately 3.3 Volts)

Failure of the collectors to track as shown may be the result of either a bad dual or excessive loading by the following differential circuit formed by Q29 and Q30. If these two stages are working

properly and the null detector does not work properly, the remaining two transistors, Q31 and Q32, are suspect and should be replaced.

5.30 Isolator. The isolator amplifier, located in the accessory module, operates as a gain of one (unity) or as a gain of 10 amplifier, depending on the range selected. (figure 5.23)

5.30.a General Check

1. With DC selected, select the 1 volt range and short the DMM input.

2. Connect microvoltmeter between common and TP2-and observe a reading of 0 $\pm$100 μV.

3. Check for approximately -8 volts at the collector (case of) Q15. Check for approximately +10 volts at the collector Q12.

4. Remove short from input and apply +1 volt.

5. Monitor output at TP2 for +10 volts.

5.30.b Output Locked Up

1. Short input and reference base of input dual to common.

2. Check bias levels as shown in schematic.

3. Check voltage drops across emitter base junctions.

4. With power off, check transistors with an ohmmeter.

5.30.c Output Fails to Voltage Zero

1. Check the voltage level of both collector leads as referenced to common.

2. If difference between the two measurements is less than 100 millivolts, replace the input dual.

3. If difference is greater than 100 millivolts, the problem is in some other part of the isolator.

5.30.d Output Fails to Current Zero

1. Check the voltage on the wiper arm of potentiometer R31.

2. If the voltage is zero or negative, the temperature-compensated voltage source consisting of Q13 and Q14 is malfunctioning.

3. If the voltage is positive, replace the input dual.

5.30.e Range Divider Check

1. Select 10 volt range and monitor TP2. Apply +10 volts and monitor +10 volts.

2. Reduce input to 1 volt and select 1 volt. Monitor 10 volts.

3. Select 1000 range and apply 1000 volts. Monitor 10 volts.

5.30.f Filter Check

1. Connect the DVM to a signal generator producing 4 volts peak-to-peak at 60 Hz.

2. Select the 10 volt range.

3. With an oscilloscope, monitor TP2 for an ac ripple content of 40 millivolts or less.

5.30.g Noise

1. Connect a jumper from the input base of the input dual to common and monitor the junction of filter capacitors C2 and C7.

2. If noisy, the most likely cause is transistor Q2 or Q3.

3. If the filter is not the cause of the noise, the cause is in the isolator and most likely the input dual.

5.31 Internal Reference. The internal reference consists of a selected reference zener supplied by a stable current generator. The current generator supplies .5 mA to the ramp generator, plus suffi-

cient current to the reference zener to allow it to operate at its zero temperature coefficient level.

5.31.a Check. Using a precision voltmeter, measure across the reference zener and verify a reading of approximately 6.2 volts. Adjust the line voltage of the DMM from 110 to 130 volts and verify that zener voltage does not change more than 100 microvolts. (figure 5.29)

5.31.b Reference Repair. Check bias levels and the voltage drop across the emitter-base junctions of the current generator.

5.32 Ramp. The ramp is an active integrating circuit which produces a linearly increasing output voltage. (figure 5.28)

5.32.a Operational Check. Place DMM in Read, select DC and the one volt range. Apply -1.5 volts to the DMM input. With an oscilloscope, monitor TP11 and verify a ramp voltage linearly increasing from -10 millivolts to +12 volts in 12 milliseconds (some ringing is acceptable prior to the ramp output crossing zero volts). If the ramp generator fails to operate correctly, perform the following checks.

5.32.b Amplifier Check. Connect a jumper across integrating capacitor C2. Monitor TP11 and verify a reading of -10 millivolts (adjust R25 if necessary).

1. Amplifier Does Not Zero

   (a) Verify approximately 2.4 volts across zener diode CR7.

   (b) Check bias levels as shown in schematic.

   (c) Check voltage drops across emitter base junctions.

   (d) With power off, check transistors with an ohmmeter.

5.32.c Switch Check. Remove jumper from across capacitor C2 and connect a jumper between TP6 and the left side of R13 (figure 5.28). Monitor TP11 and verify a reading of approximately +10 volts.

1. Reads Approximately Zero Volts. Replace Q3.

5.32.d Inverter Check. Remove jumper from R13 and connect a jumper from TP6 to left side of R10 (figure 5.28). Monitor TP11 and verify a reading of approximately zero volts.

1. Reads approximately 10 volts. Replace Q2.

5.33 Auto Polarity. The auto polarity circuit is an operational amplifier having polarity-selected feedback paths. (figure 5.27)

5.33.a Diode Check. Remove power from DMM. With an ohmmeter, check the forward and back resistance of diodes CR8 and CR9. The resistive readings of the two diodes should be approximately the same.

5.33.b Amplifier Check. Select DC, the 10 volt range and Read. Connect the DMM input to -9 volts.

   (a) With a voltmeter, monitor TP8 and verify a reading of approximately zero volts.

   (b) Change the polarity of the input voltage to positive (+9 volts).

   (c) Monitor TP8 and verify a reading of -9 volts $\pm$20 millivolts.

5.33.c Troubleshooting

   (a) Short input base to common (TP6).

   (b) Check bias levels as shown in schematic

   (c) Check voltage drops across the emitter base junctions.

   (d) With power off, check transistors with an ohmmeter.

5.34 Rate Control. Select DC, Read and 10 volt range with a scope. Monitor TP15 and verify a positive 0.5 millisecond pulse (figure 5.26). If pulse does not appear, check Q34 and Q35. Place

DMM in HOLD. Monitor TP15 and verify approximately zero volts. (figure 5.26)

5.35 Polarity Sense. The polarity sense circuit monitors the output of the auto polarity and controls the polarity drive circuit. Check Select DC, the 10 volt range and READ. Connect the common lead of an oscilloscope to TP6. Connect the DMM input to a DC source (1.5 volts nominal). With the scope input lead, probe the right side of resistors R65 and R66 (as viewed in figure 5.25) and take measurements with the input in both polarities as shown in Table 5.4.

Table 5.4. Polarity Sense

Probe	With + Polarity Read	With - Polarity Read
R65	+1.5	- .5
R66	- .5	+1.5

5.36 Overload. Select DC, the 1 volt range and READ. Connect the DMM input to -1.5 volts. (figure 5.25)

1. DMM reads 00000 and overload lights. Replace M10.

2. Overload lights with DMM display at 0.2000 or at 1.0000. Replace M11.

3. DMM reads over 1.2000 and overload does not light. Monitor M10-6 for approximately zero volts.

   (a) M10-6 is zero volts. Replace M10.

   (b) M10-6 is approximately +3 volts. Replace M11.

4. DMM reads 1.2000 and overload does not light. Replace Q45.

5.37 Switch Check. The front-panel pushbutton switches may be a source of trouble, but are easily checked with a VOM. Remove power from the DMM and remove the accessory drawer from the instrument. Switch terminals (or pins) are accessible on the top of each switch, and the pin numbers are given on the schematic for the module being checked. Use the R x 1 range of the VOM. (Resistance values are approximate.)

5.37.a Range Switches. Select Autorange. Verify 0 ohms across pins 2 and 3 and pins 5 and 6 of the autorange switch. Verify 0 ohms across pins 1 and 2 and pins 4 and 5 of range switches 1 through 1000. Select the 1 range switch and verify 0 ohms across pins 2 and 3 and pins 4 and 5. Repeat the check with range switches 10, 100 and 1000.

5.37.b Function Switches (Module 220 only). Select DC. Verify 0 ohms across pins 2 and 3 and pins 5 and 6 of the DC switch. Verify 0 ohms across pins 1 and 2, 4 and 5, 7 and 8, and pins 10 and 11 of the AC switch. Select AC. Verify 0 ohms across pins 1 and 2 and pins 4 and 5 of the DC switch. Verify 0 ohms across pins 2 and 3, 5 and 6, 8 and 9, and pins 11 and 12 of the AC switch.

5.37.c Calibrate Switch. Verify 0 ohms across pins 1 and 2, 4 and 5, 7 and 8, and pins 10 and 11 of the Calibrate switch. Depress the Calibrate switch and verify 0 ohms across pins 2 and 3, 5 and 6, 8 and 9 and pins 11 and 12 of the Calibrate switch.

5.38 Range Display Logic. The output of the range display logic (M4 located on the accessory module, is accessible on readout board on the left side of resistors R103, R98, R90 and R79 as viewed in figure 5.24. Select DC and Read. Connect the common lead of a voltmeter to input common. All voltage measurements are approximate.

5.38.a 1 Volt Range. Select the 1 volt range. Verify a reading of +3.5 volts at R103 and 0 volts at R98, R90 and R79.

5.38.b 10 Volt Range. Select the 10 volt range. Verify a reading of +3.5 volts at R98 and 0 volts at R103, R90 and R79.

5.38.c 100 Volt Range. Select the 100 volts range. Verify a reading of +3.5 volts at R90 and 0 volts at R103, R98 and R97.

5.38.d Select the 1000 volt range. Verify a reading of +3.5 volts at R79 and 0 volts at R103, R98 and R90. If the instrument fails on any of the above checks, replace M4 on the accessory module.

5.39 Range Divider. The range divider includes a 100 to 1 voltage divider and a gain of ten feedback network for the isolator (see paragraph 4.8).

5.39.a Check

1. Select 10 volt range and monitor TP2 on the readout board. Apply +10 volts and monitor +10 volts.

2. Reduce input to 1 volt and select 1 volt. Monitor 10 volts at TP2.

3. Select 1000 range and apply 1000 volts. Monitor 10 volts at TP2.

5.39.b Troubleshooting

1. If the range divider does not range properly, check transistors Q1 and Q20 on the accessory module.

2. The 1000 range does not calibrate. Check the voltage divider resistors.

3. The 1 range does not calibrate. Check feedback resistors R48, R49, R51, R52 and R53.

5.40 Range Logic. The range logic generates a down signal to the autorange circuit for measurements of 00999 or less and an up-range signal for measurements which cause the instrument to overload. The down-range signal is cancelled when the DMM is in the lowest range, and the up-range signal is cancelled when the DMM is in the highest range. (figure 5.23)

5.40.a DMM does not down range. Refer to figure 5.19.

5.40.b DMM does not up range. Refer to figure 5.16.

5.41 Calibrate. Connect the common lead of a precision voltmeter to TP6 and the input lead to the bottom of resistor R18 (as viewed in figure 5.29). Verify a reading of -1.0 volts.

5.41.a Reading is not -1.0 volt. Check resistors R15, R16 and R18.

5.41.b Reading is -1.0 volt. Refer to the calibrate switch check, paragraph 5.37.

5.42 AC Converter. The AC Converter consists of a voltage attenuator, a gain of 1 amplifier, and an active rectifier circuit.

5.42.a With an oscilloscope referenced to input common, monitor the junction of the gate of Q1 and diodes CR8 and CR9. Verify a .5 volt rms (.7 volts peak-to-peak), 400 Hz signal.

(1) Reads zero - Check AC Select switch.

(2) Reads low - Refer to paragraph 5.43.

5.42.b Monitor the source of Q1 with the oscilloscope and verify a .5 volt rms, 400 Hz signal.

(1) Check transistors Q2 and Q5 for shorts or opens.

(2) Check Fet transistor Q1 for a short or open.

5.42.c Monitor E12 and verify a -2.4 peak halfwave signal riding on a -0.14 volt dc level.

(1) Check bias levels shown on schematic.

(2) Check the voltage drops across the emitter base junctions of transistors Q7 through Q13.

(3) Check diodes CR6 and CR7.

5.43 AC Converter Voltage Attenuator Check

5.43.a Repeat step 5.42.a.

(1) Reads 1.0 volt rms — check resistors R9 and R10 for opens.

(2) Reads low – with a VOM, check for a short (an energized relay) between the contacts of relays K1, K2 and K3. Eliminate cause of short.

5.43.b Select 10 range and increase AC source to 10 volts rms. Verify a DMM reading of approximately 10.000.

5.43.c Select 100 range and increase AC source to 100 volts rms. Verify a DMM reading of approximately 100.00.

5.43.d Select 1000 range and increase AC source to 125 volts rms. Verify a DMM reading of approximately 0125.0.

5.43.e If the DMM fails in steps b, c or d, check the relays and relay drivers.

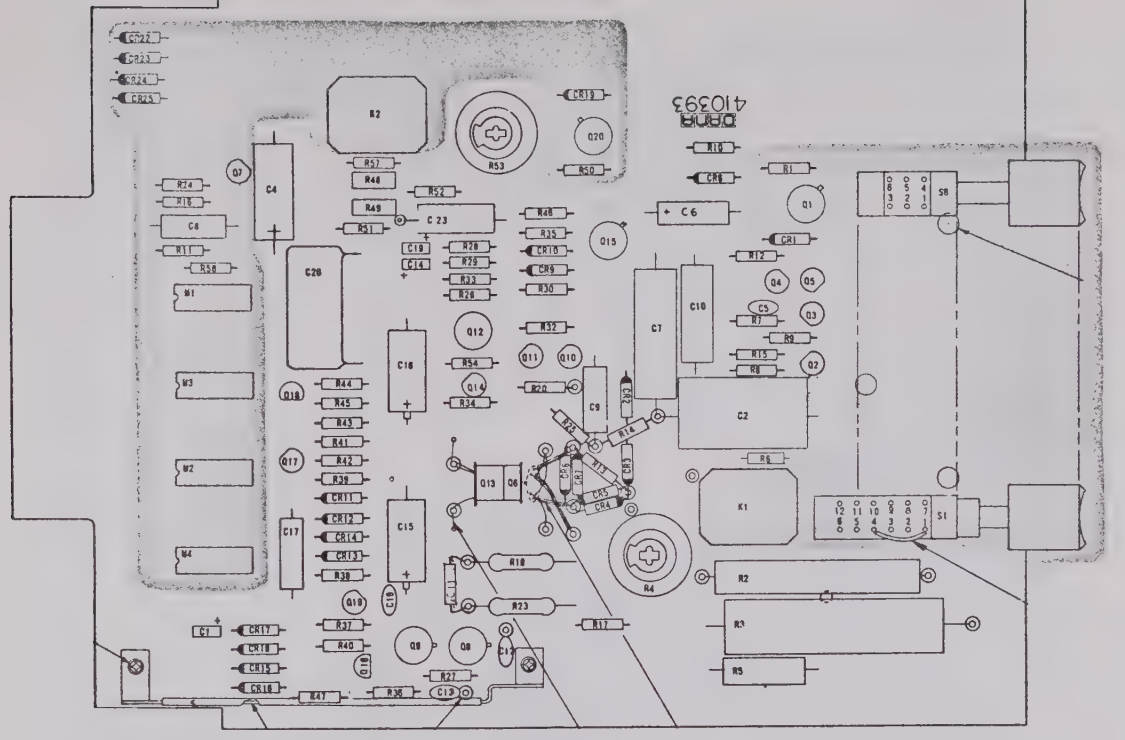


Figure 5.23 - Ranging Circuit

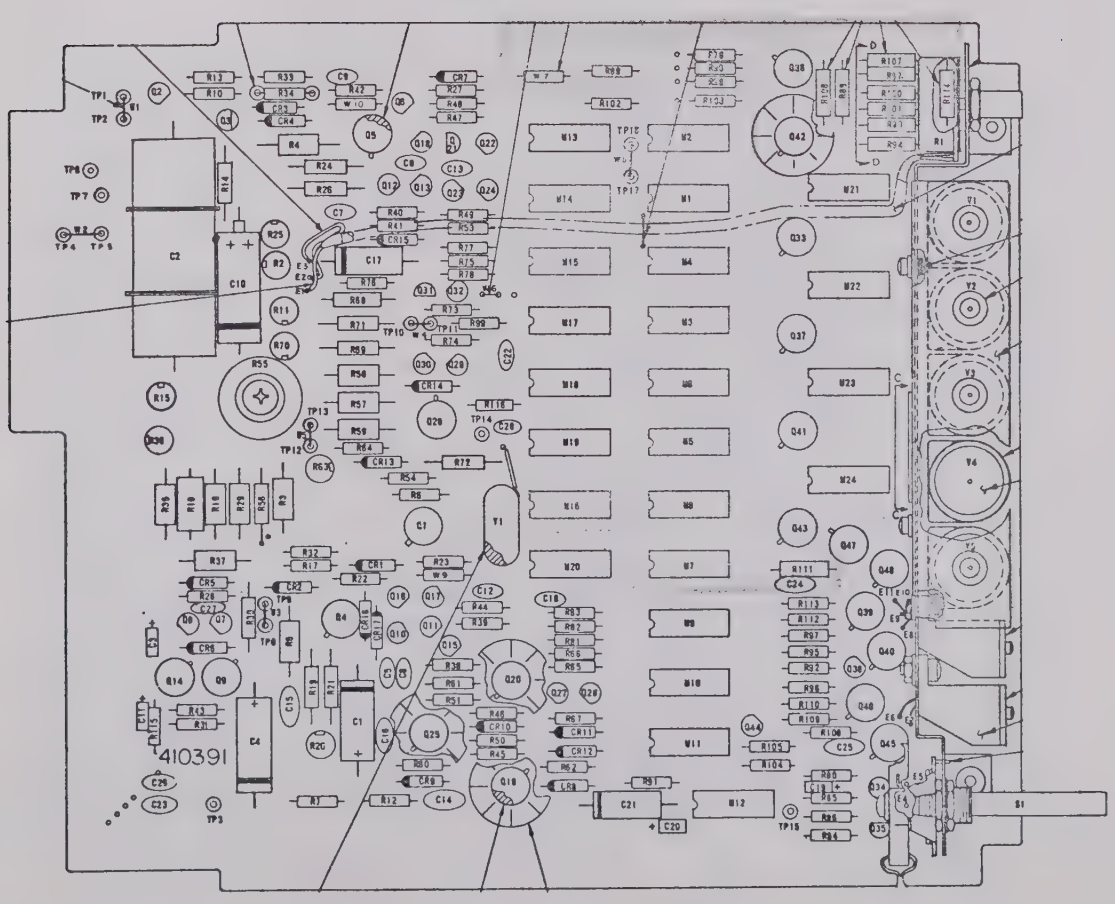


Figure 5.24 - Counter & Display

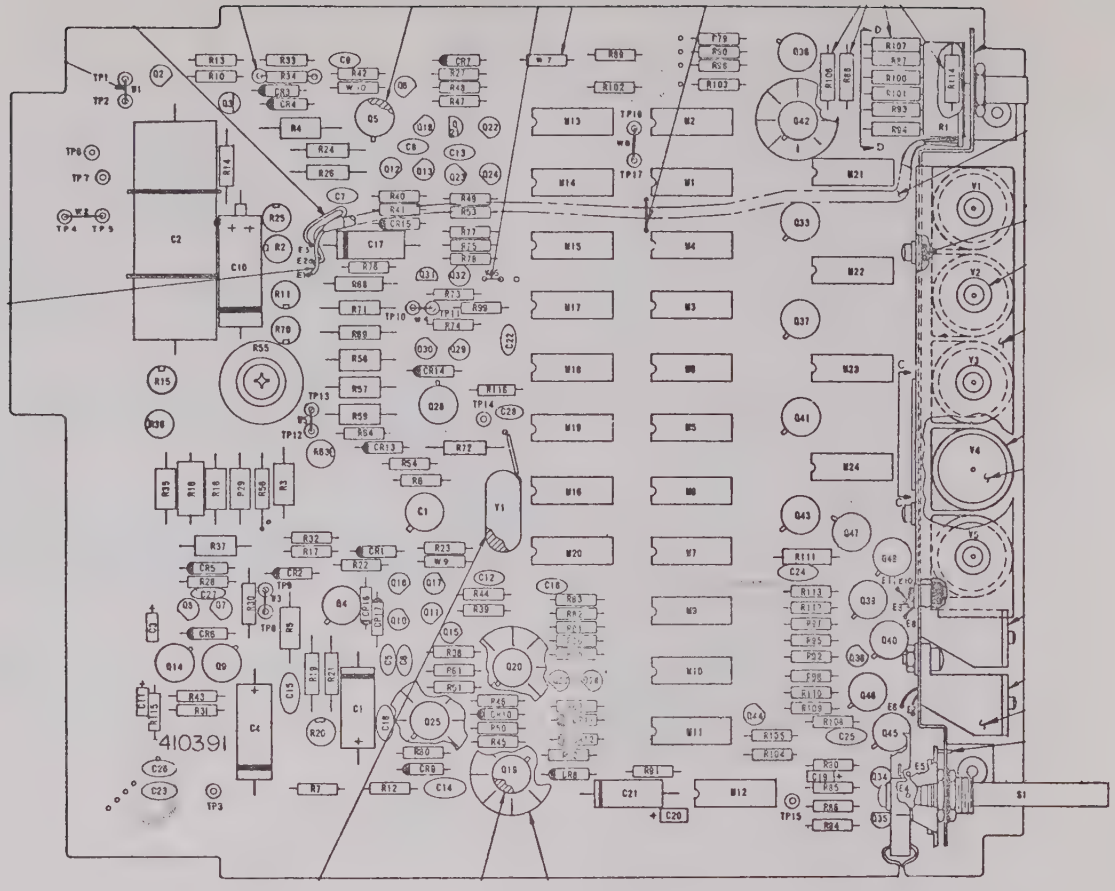


Figure 5.25 - Logic

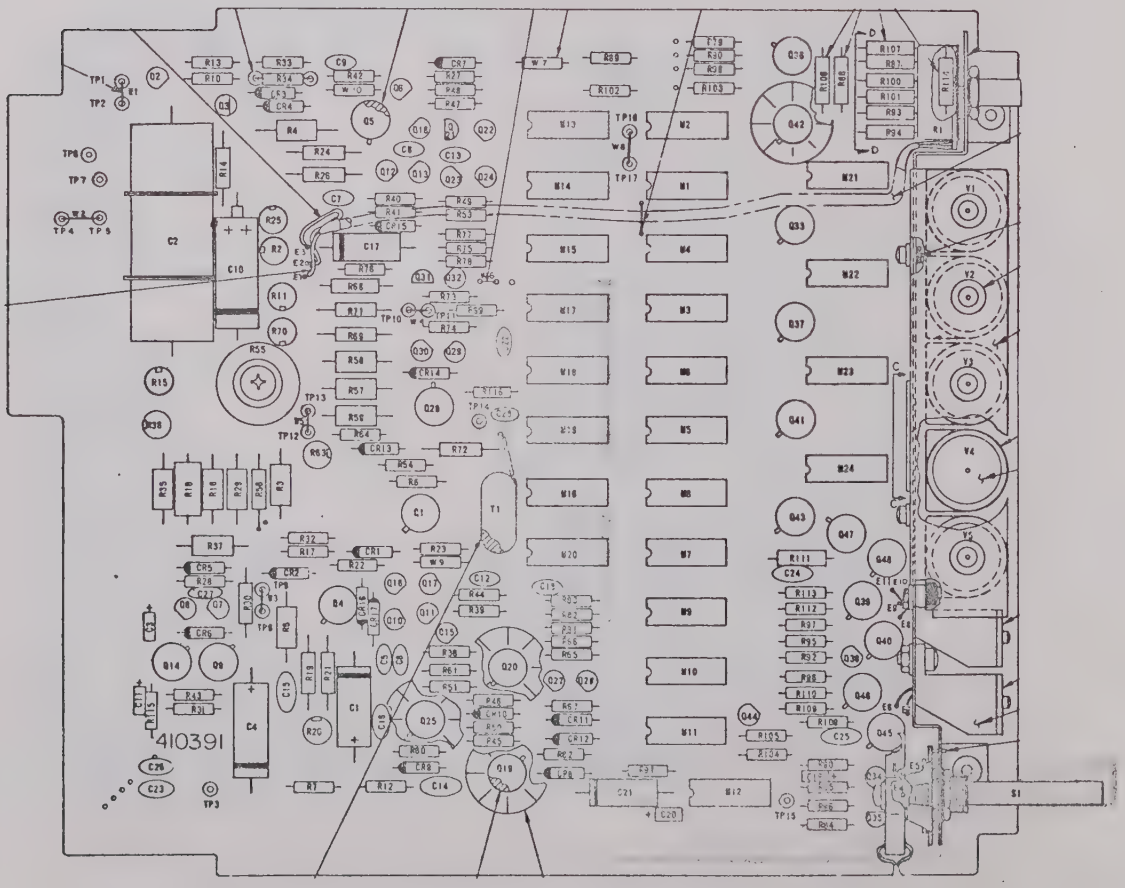


Figure 5.26 - Logic Control

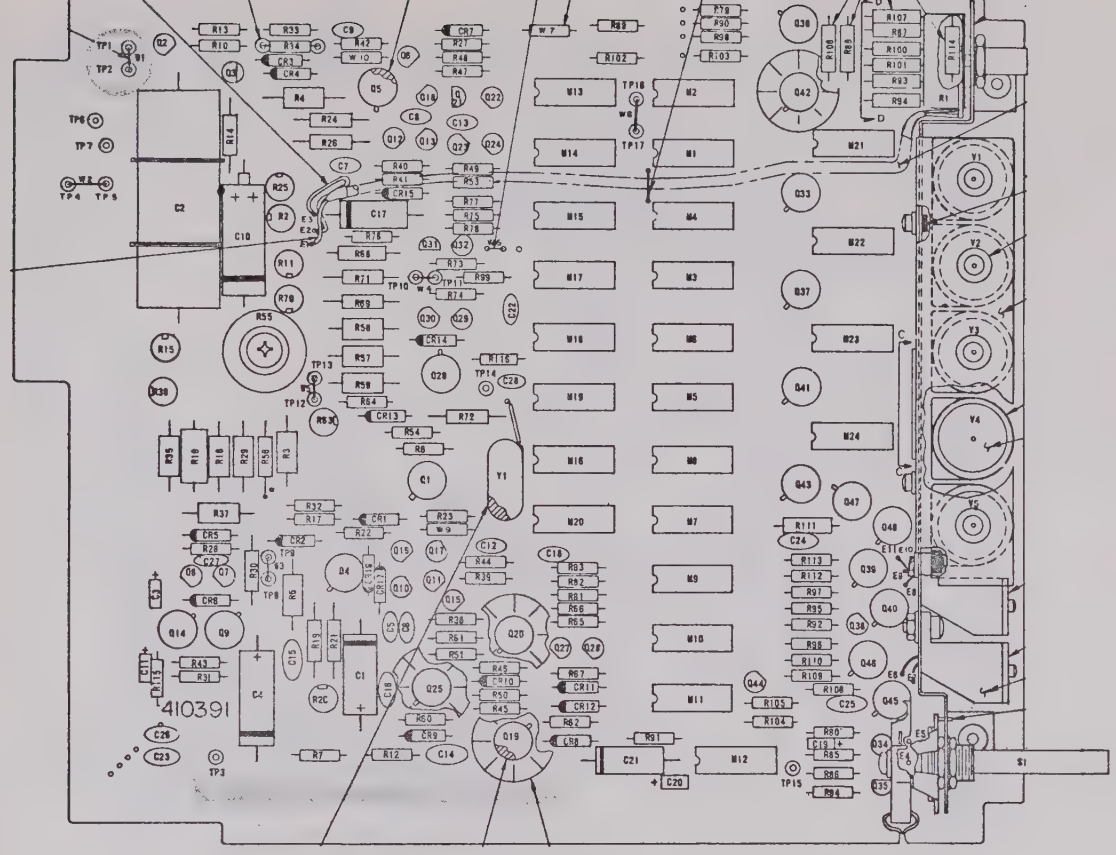


Figure 5.27 - Auto Polarity

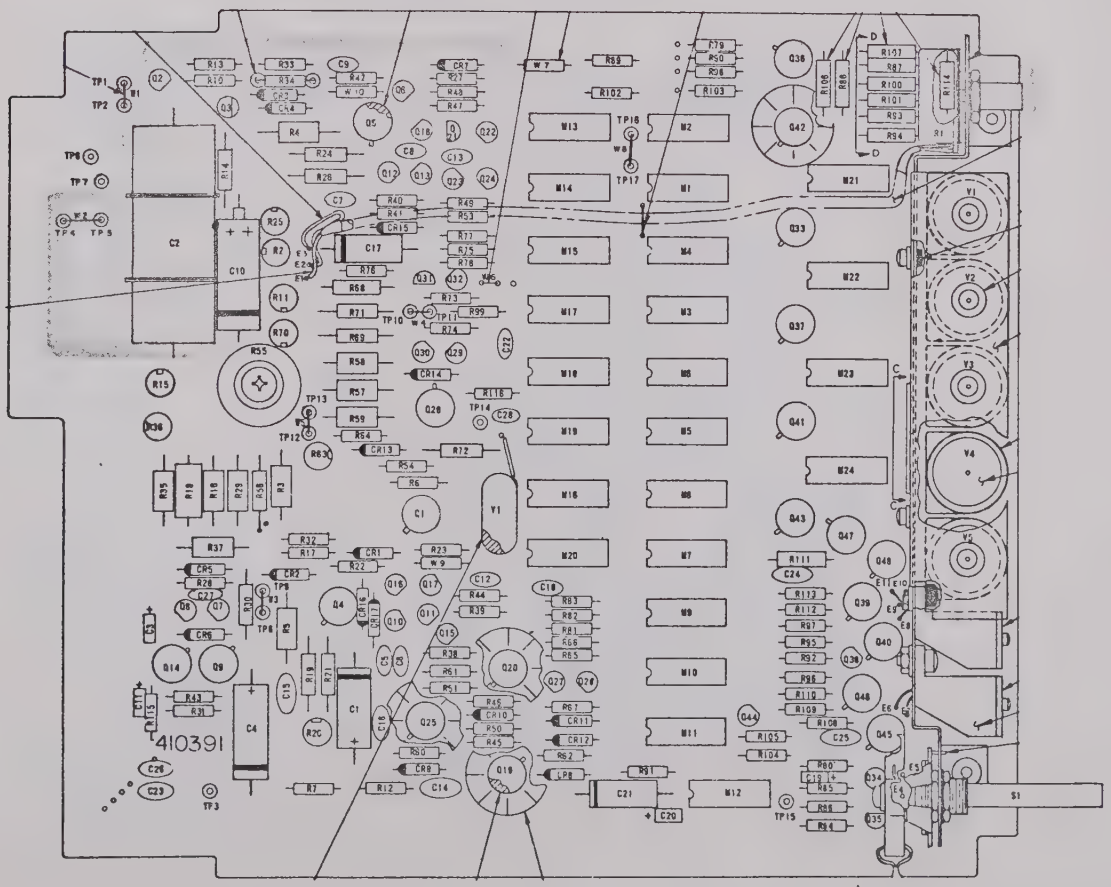


Figure 5.28 - Ramp

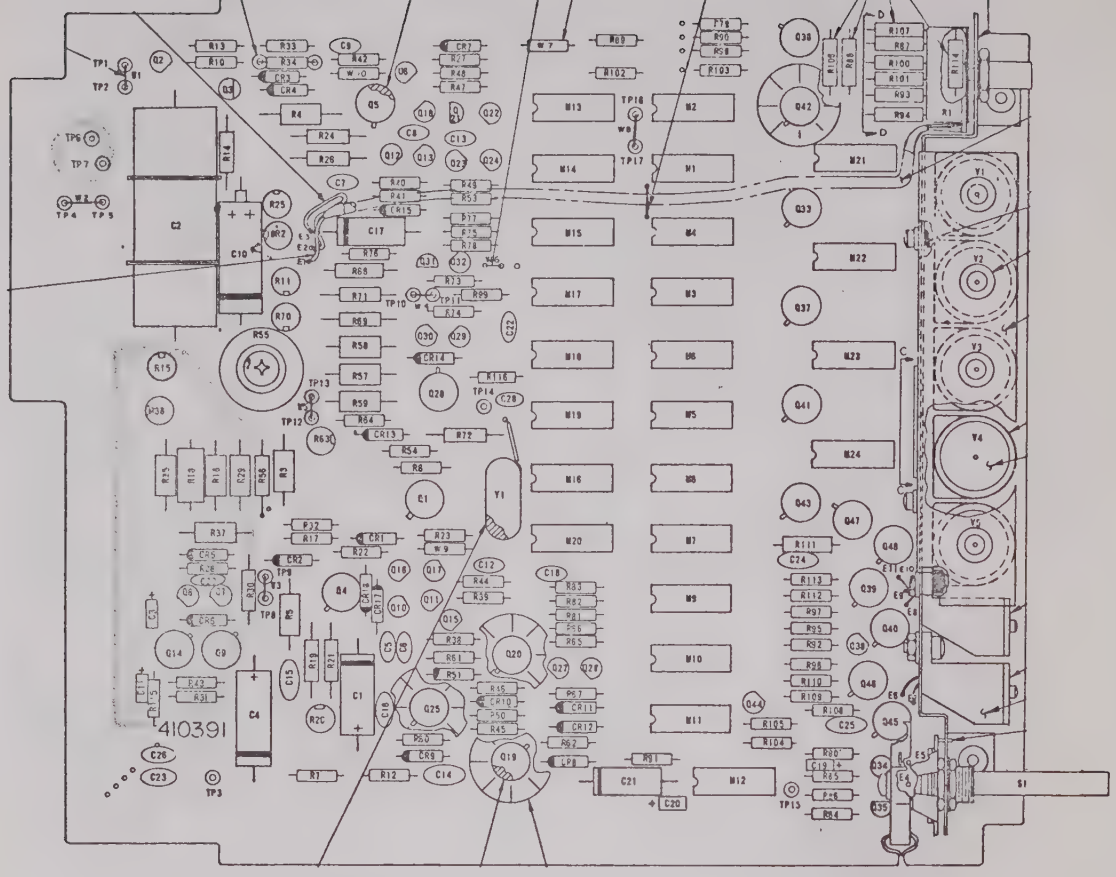


Figure 5.29 - Internal Reference

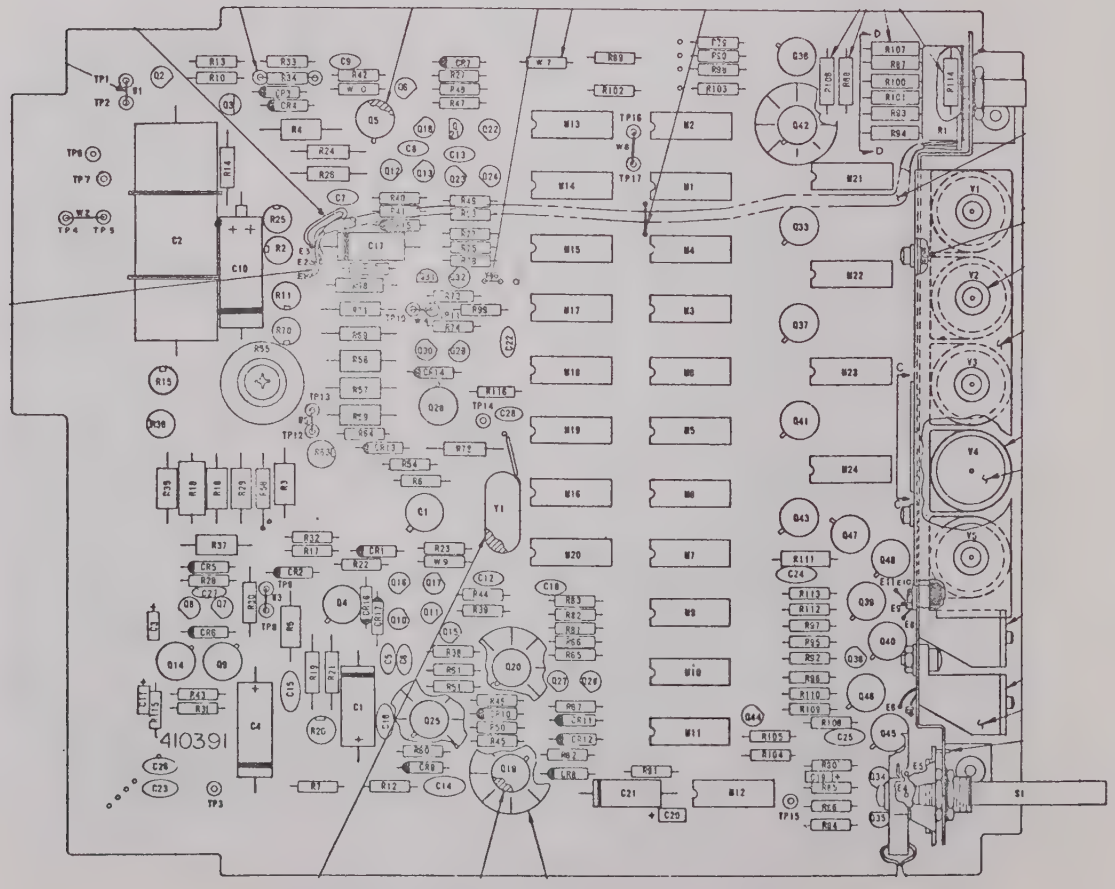


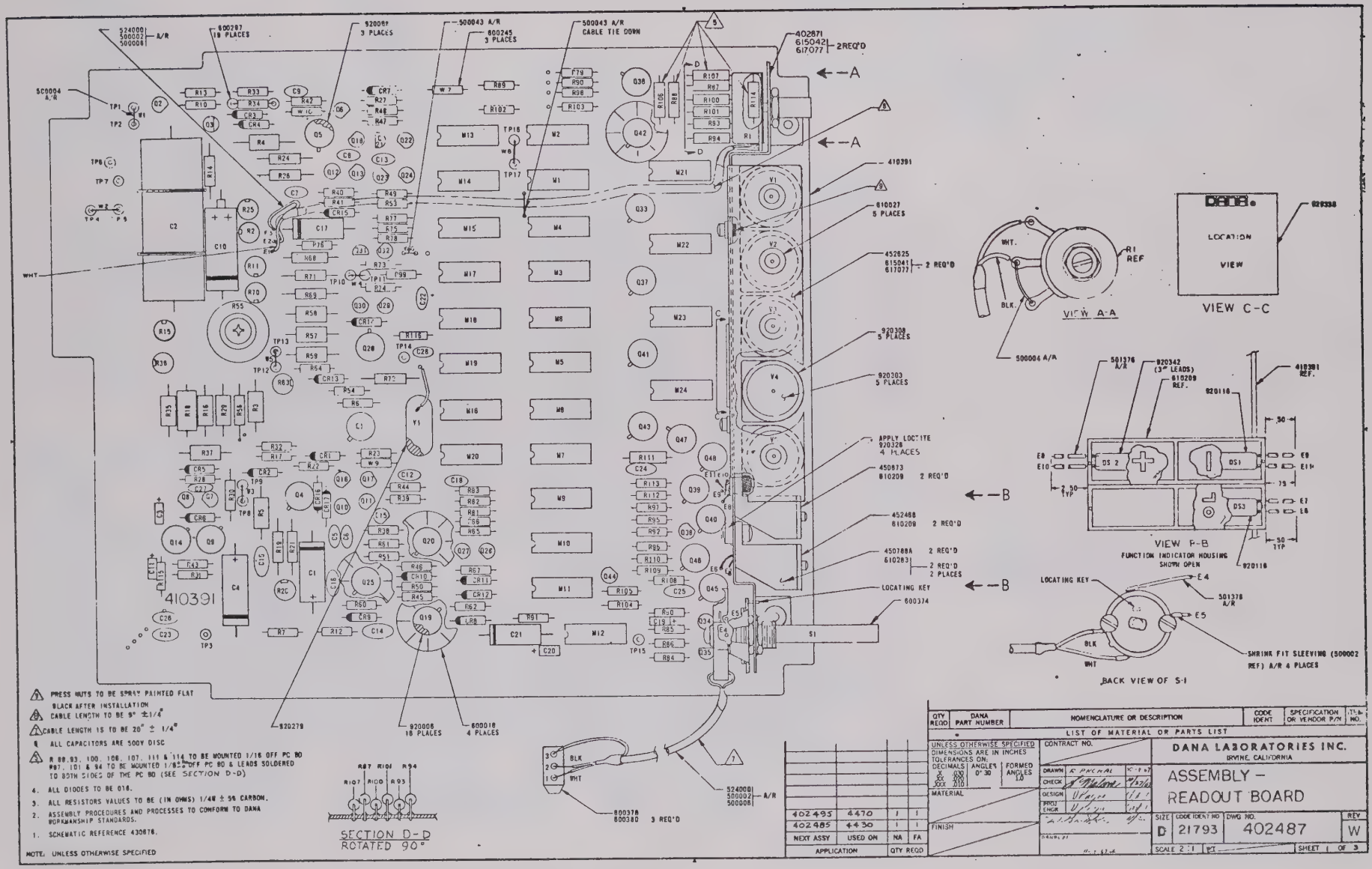
Figure 5.30 - Null Detector

SECTION 6

DRAWINGS

6.1 DRAWINGS

Readout Assembly	402487
Readout Schematic	430676
Power Supply Assembly, 4430	402488
Power Supply Assembly, 4470	402497
PCB Assembly - Power Supply, 4470	402498
Power Supply Schematic	430677
PCB Assembly - Power Supply, 4430	402489
PCB Assembly - DC Auto, 210	402493
Schematic - DC Auto, 210	430678
Isolator AC/DC Assembly, 220	402515
Isolator AC/DC Schematic, 220	430695
AC/DC Converter Assembly, 220	402543
AC/DC Converter Schematic, 220	430695



⚠ PRESS NUTS TO BE SPRAY PAINTED FLAT BLACK AFTER INSTALLATION

⚠ CABLE LENGTH TO BE 9" ±1/4"

⚠ CABLE LENGTH IS TO BE 20" ± 1/4"

6. ALL CAPACITORS ARE 500V DISC

⚠ R 88,93, 100, 106, 107, 111 & 114 TO BE MOUNTED 1/16 OFF PC BD
R97, 101 & 94 TO BE MOUNTED 1/8" OFF PC BD & LEADS SOLDERED TO BOTH SIDES OF THE PC BD (SEE SECTION D-D)

4. ALL DIODES TO BE 016.

3. ALL RESISTORS VALUES TO BE (IN OHMS) 1/4W ± 5% CARBON.

2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS.

1. SCHEMATIC REFERENCE 430878.

NOTE: UNLESS OTHERWISE SPECIFIED

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
402495	4470		1	1	
402485	4430		1	1	
NEXT ASSY	USED ON		NA	FA	
APPLICATION			QTY REQD		

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS X .XXX .XX .XXX | ANGLES 0° 30' | FORMED ANGLES ±0

MATERIAL

FINISH

CONTRACT NO.

DRAWN S. RACHAL

CHECK

DESIGN

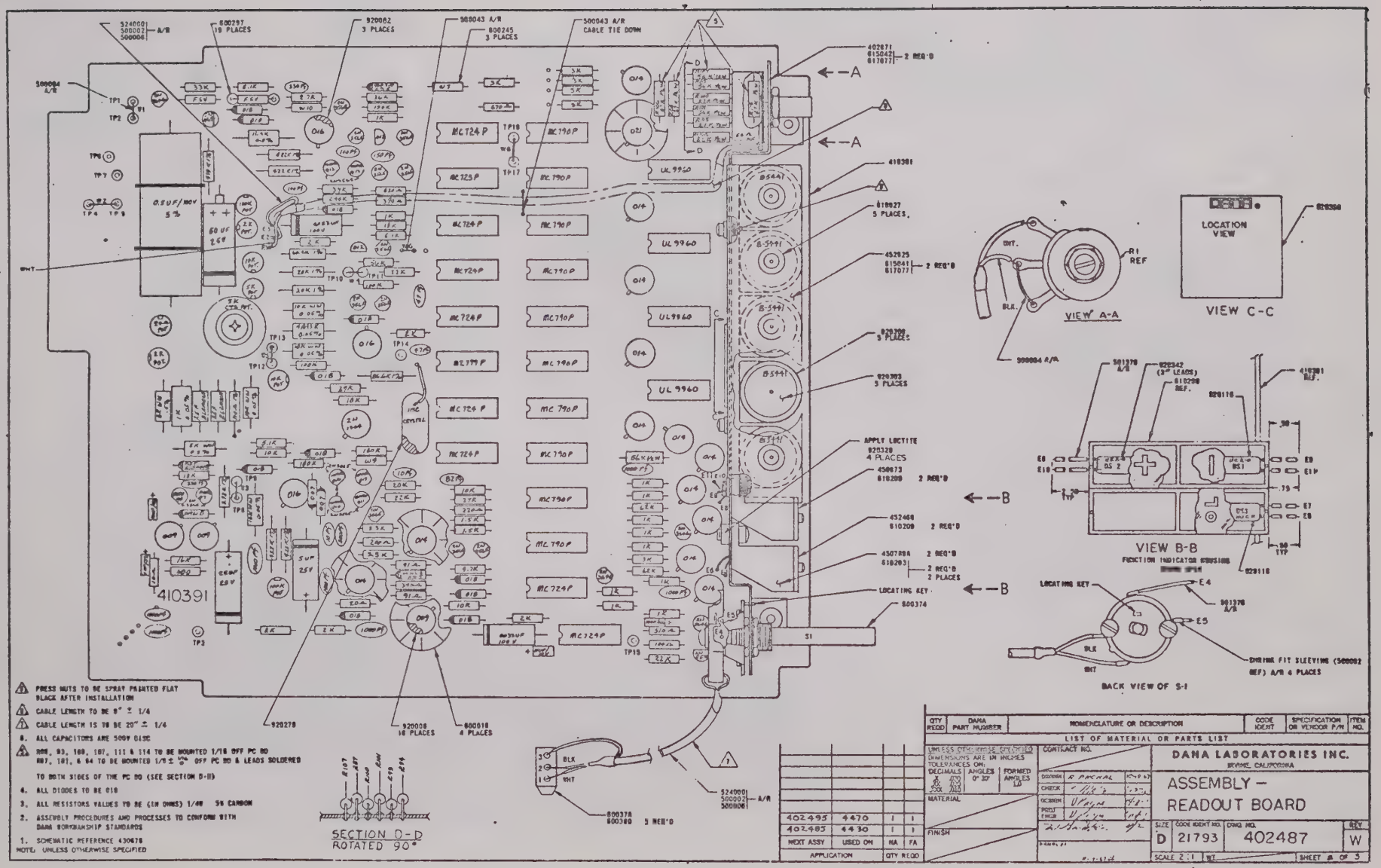
PROJ ENGR

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSEMBLY – READOUT BOARD

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	402487	W

SCALE 2:1 | WT | SHEET 1 OF 3



1. SCHEMATIC REFERENCE 430478
2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS
3. ALL RESISTORS VALUES TO BE (IN OHMS) 1/4W 5% CARBON
4. ALL DIODES TO BE 018
5. R88, 93, 100, 107, 111 & 114 TO BE MOUNTED 1/16 OFF PC BD
   R87, 101, & 64 TO BE MOUNTED 1/16 ± 1/32 OFF PC BD & LEADS SOLDERED TO BOTH SIDES OF THE PC BD (SEE SECTION D-D)
6. ALL CAPACITORS ARE 500V DISC
7. CABLE LENGTH IS TO BE 20" ± 1/4
8. CABLE LENGTH IS TO BE 9" ± 1/4
9. PRESS NUTS TO BE SPRAY PAINTED FLAT BLACK AFTER INSTALLATION

NOTE: UNLESS OTHERWISE SPECIFIED

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
1	402495	4470	1	1	
1	402485	4430	1	1	
NEXT ASSY	USED ON		NA	FA	
APPLICATION			QTY REQD		

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON: DECIMALS .X ±.03, .XX ±.01, .XXX ±.005; ANGLES 0° 30'; FORMED ANGLES ±1°

MATERIAL

FINISH

CONTRACT NO.

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

DESIGN R. PACHAL 5-10-77
CHECK 5-11-77
QC DESIGN 5-11-77
PROJ ENGR 5-11-77

ASSEMBLY — READOUT BOARD

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402487	W

SCALE 2:1 WT SHEET 1 OF 3

REF DES OR ITEM	P/N	DESCRIPTION	QTY
C1	110068	5UF/25V	1
C2	120174	8.5UF/100V SG	1
C3	110068	10UF/10V	3
C4	110043	25UF/25V	1
C5	100006	10pF DISC	2
C6	101093	330pF DISC	3
C7	101145	100 pF DISC	2
C8	101145	100 pF DISC	REF
C9	101058	330pF DISC	REF
C10	110047	50UF/25V	1
C11	110071	1UF/35V	1
C12	100006	10pF DISC	REF
C13	101042	150pF DISC	1
C14	101174	1000pF DISC	7
C15	101174	1000pF DISC	REF
C16	101174	1000pF DISC	REF
C17	121081	0.033UF/100V	2
C18	100008	82pF DISC	1
C19	110068	10UF/10V	REF
C20	110068	10UF/10V	REF
C21	121081	0.033UF/100V	REF
C22	101182	47pF DISC	2
C23	101174	1000pF DISC	REF
C24	101174	1000pF DISC	REF
C25	101174	1000pF DISC	REF
C26	101174	1000pF DISC	REF
C27	101098	330pF DISC	REF
C28	101182	47pF DISC	REF

REF DES OR ITEM	P/N	DESCRIPTION	QTY
W9	230003	MC790P	REF
W10	230003	MC790P	REF
W11	230000	MC724P	8
W12	230000	MC724P	REF
W13	230000	MC724P	REF
W14	230015	MC723P	1
W15	230000	MC724P	REF
W16	230000	MC724P	REF
W17	230000	MC724P	REF
W18	230000	MC724P	REF
W19	230006	MC789P	1
W20	230000	MC724P	REF
W21	230014	UL8980	4
W22	230014	UL8980	REF
W23	230014	UL8980	REF
W24	230014	UL8980	REF
Q1	281084	2N1304	1
Q2	200037	2N3646	4
Q3	200082	2N5424	1
Q4	200040	D18	3
Q5	200040	D18	REF
Q6	200043	2N3565	11
Q7	200044	MATCHED W/Q8	4
Q8	200044	MATCHED W/Q7	REF
Q9	200052	D09	3
Q10	200044	MATCHED W/Q16	REF
Q11	200044	MATCHED W/Q17	REF
Q12	200044	MATCHED W/Q13	REF
Q13	200044	MATCHED W/Q12	REF
Q14	200052	D09	REF

REF DES OR ITEM	P/N	DESCRIPTION	QTY
Q46	200035	D14	REF
Q47	200035	D14	REF
Q48	200035	D14	REF
R1	040101	50 OHM WW POT	1
R2	040086	2k POT	2
R3	020241	10k WW 0.05%	4
R4	020391	11.4k 0.5%	1
R5	020241	10k WW 0.05%	REF
R6	000183	18k	3
R7	000202	2k	5
R8			
R9			
R10	000102	1k	12
R11	040087	10k POT	2
R12	000202	2k	REF
R13	000333	33k	1
R14	019149	499k 1%	1
R15	040098	20 OHM POT	1
*R16	402467	REF ELEMENT	REF
R17	000103	10k	3
R18	020390	1k 0.05%	1
R19	010038	422k 1%	4
R20	040088	100k POT	2
R21	010038	422k 1%	REF
R22	000184	180k	2
R23	000184	180k	REF
R24	010038	422k 1%	REF
R25	040088	100k POT	REF
R26	010038	422k 1%	REF

REF DES OR ITEM	P/N	DESCRIPTION	QTY
R58	020241	10k WW 0.05%	REF
R58	020241	10k WW 0.05%	REF
R80	000200	20 OHM	1
R81	000201	200 OHM	1
R82	000103	10k	REF
R83	040087	10k POT	REF
R84	000104	100k	2
R85	000152	1.5k	2
R86	000152	1.5k	REF
R87	000472	4.7k	REF
R68	010013	60.4k 1%	1
R69	010059	20k 1%	2
R70	040087	5k POT	1
R71	010059	20k 1%	REF
R72	010078	86.6k 1%	1
R73	000563	56k	1
R74	000104	100k	REF
R75	000183	18k	REF
R76	000202	2k	REF
R77	000102	1k	REF
R78	000512	5.1k	REF
R79	000302	5K	6
R80	000102	1k	REF
R81	000221	220 OHM	1
R82	000273	27k	1
R83	000103	10k	REF
R84	000223	22k	REF
R85	000511	510 OHM	1
R86	000101	100 OHM	1
R87	001745	56k 1/2W	5
R88	001744	27k 1/2W	5

REF DES OR ITEM	P/N	DESCRIPTION	QTY
V1	920303	TUBE B-5441	5
V2	920303		REF
V3	920303		REF
V4	920303		REF
V5	920303	TUBE B-5441	REF
Y1	920301	XNC CRYSTAL	1

P/N	DESCRIPTION	QTY
410391	PCB READOUT MODULE	1
430676	SCHEMATIC READOUT MODULE	REF
450788	HOUSING FUNCTION READOUT	2
450873	DISPLAY SCREEN-POLARITY	1
452468	DISPLAY SCREEN OVERLOAD	1
402871	ASSY-READOUT BRKT	1
452625	BRKT-RETAINER READOUT TUBE	1
500002	TUBING-SHRINK	A/R
500004	BUSS WIRE	A/R
500006	CABLE-STORM	2
500037	WIRE-BUSS	2
500043	WIRE-WHITE TEFLON COATED	2
500054	TUBING-PLASTIC	A R
501356	SHRINK TUBING	A R
524000	WIRE-O COLOR	A R
524993	WIRE-9 COLOR	A R
600018	HEAT SINK	4
600245	JUMPER-INSUL	3
600297	CONN-PC JACK	19
600378	CONNECTOR-PLUG	1
600380	PIN-PLUG	3
610027	GROMMET-RUB BL	5
610209	SCR-PPH#2-56 X3/16 LG F SELFTAP	4
610283	SCR-#4-40 PPH X 1/4 BLK OXIDE	4
615041	SCR PPH 4-40 X 3/16	2
615042	SCR PPH 4-40 X 1/4	2
617077	WASHER INT LOCK 4	4
920006	TRANS PAD-LARGE	18
920010	SOLDER-BAR	2
920026	SOLDER-WIRE	2
920082	TRANS PAD DUAL	3
920279	CRYSTAL PAD	1
920308	SOCKET-NIXIE	5
920339	LABEL-ZENER KIT	1
920340	LOCTITE	A/R

REF DES OR ITEM	P/N	DESCRIPTION	QTY
CR1	211083	D18	19
CR2	211083	D18	REF
CR3	211083	D18	REF
CR4	211083	D18	REF
*CR5	402487	REF ELEMENT	1
CR6	220004	1N7818	1
CR7	221177	1/4W2.4A2%	2
CR8	211083	D18	REF
CR9	211083	D18	REF
CR10	221177	1/4W2.4A2%	REF
CR11	211083	D18	REF
CR12	211083	D18	REF
CR13	211083	D18	REF
CR14	211083	D18	REF
CR15	211083	D18	REF
CR16	211236	D07	2
CR17	211236	D07	REF
DS1	920118	LAMP NE2M	2
DS2	920342	LAMP NE2M(SPECL)	1
DS3	920118	LAMP NE2M	REF
U1	230003	MC790P	10
U2			REF
U3			
U4			
U5			
U6			
U7			
U8	230003	MC790P	REF

REF DES OR ITEM	P/N	DESCRIPTION	QTY
Q15	200043	2N3565	REF
Q16	200044	MATCHED W/Q10	REF
Q17	200044	MATCHED W/Q11	REF
Q18	200043	2N3565	REF
Q19	200052	D09	REF
Q20	200035	D14	13
Q21	200022	D12	2
Q22	200043	2N3565	REF
Q23	200043	2N3565	REF
Q24	200043	2N3565	REF
Q25	200035	D14	REF
Q26	200043	2N3565	REF
Q27	200043	2N3565	REF
Q28	200040	D18	REF
Q29	200043	2N3565	REF
Q30	200043	2N3565	REF
Q31	200022	D12	REF
Q32	200043	2N3565	REF
Q33	200035	D14	REF
Q34	200037	2N3646	REF
Q35	200075	2N4870	1
Q36	200035	D14	REF
Q37	200035	D14	REF
Q38	200037	2N3646	REF
Q39	200035	D14	REF
Q40	200035	D14	REF
Q41	200035	D14	REF
Q42	200079	D21	1
Q43	200035	D14	REF
Q44	200037	2N3646	REF
Q45	200035	D14	REF

REF DES OR ITEM	P/N	DESCRIPTION	QTY
R27	000363	36k	1
R28	000183	18k	REF
*R29	402487	REF ELEMENT	REF
R30	010083	3.82k 1%	1
R31	000881	880 OHM	1
R32	000512	5.1k	2
R33	000512	5.1k	REF
R34	001737	FSV	1
R35	020468	6k WW 0.5%	1
R36	040086	2k POT	REF
R37	020389	5kW8 0.5%	1
R38	000332	3.3k	2
R39	000223	22k	3
R40	000393	39k	2
R41	000244	240k	1
R42	000272	2.7k	1
R43	000183	18k	1
R44	000203	20k	1
R45	000910	91 OHM	2
R48	000910	91 OHM	REF
R47	000102	1k	REF
R48	C..0154	150k	1
R49	000821	820 OHM	1
R50	000391	390 OHM	2
R51	000352	3.3 K	REF
R52	000412	4.7 K	1
R53	000391	390 OHM	REF
R54	000353	39k	REF
R55	040053	5k CTS POT	1
R56	010137	100 OHM 1%	1
R57	020406	4.893k 0.05%	1

REF DES OR ITEM	P/N	DESCRIPTION	QTY
R89	000302	3k	REF
R90	000302	3k	REF
R91	000202	2k	REF
R92	000102	1k	REF
R93	001744	27k 1/2W	REF
R94	001745	56k 1/2W	REF
R95	000102	1k	REF
R96	000102	1k	REF
R97	000623	62k	2
R98	000302	3k	REF
R99	000223	22k	REF
R100	001744	27k 1/2W	REF
R101	001745	56k 1/2W	REF
R102	000471	470 OHM	1
R103	000302	3k	REF
R104	000102	1k	REF
R105	000102	1k	REF
R106	001744	27k 1/2W	REF
R107	001745	56k 1/2W	REF
R108	000102	1k	REF
R109	000623	62k	REF
R110	000302	3k	REF
R111	001745	56k 1/2W	REF
R112	000102	1k	REF
R113	000102	1k	REF
R114	001744	27k 1/2W	REF
R115	000100	10 OHM	1
R116	000202	2k	REF
S1	600374	SWITCH-ROTARY	1

402495	4470	1	1	
4024-5	4430	1	1	FINISH
NEXT DWG	USED ON	NEXT DWG	FINAL ASSY	
APPLICATION		QTY REQD		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS ANG ° HOLE DIAMETERS
.X .030 0 ° +.004
.XX .020 FORM .D -.001
.XXX .010
MATERIAL

DRAWN	R PRUHAL	10-18-67
CHECK	L MULVEY	10-25-67
DESIGN	D PAYNE	10-27-67
MECH ENGR		
PROJ ENGR	D PAYNE	10-27-67

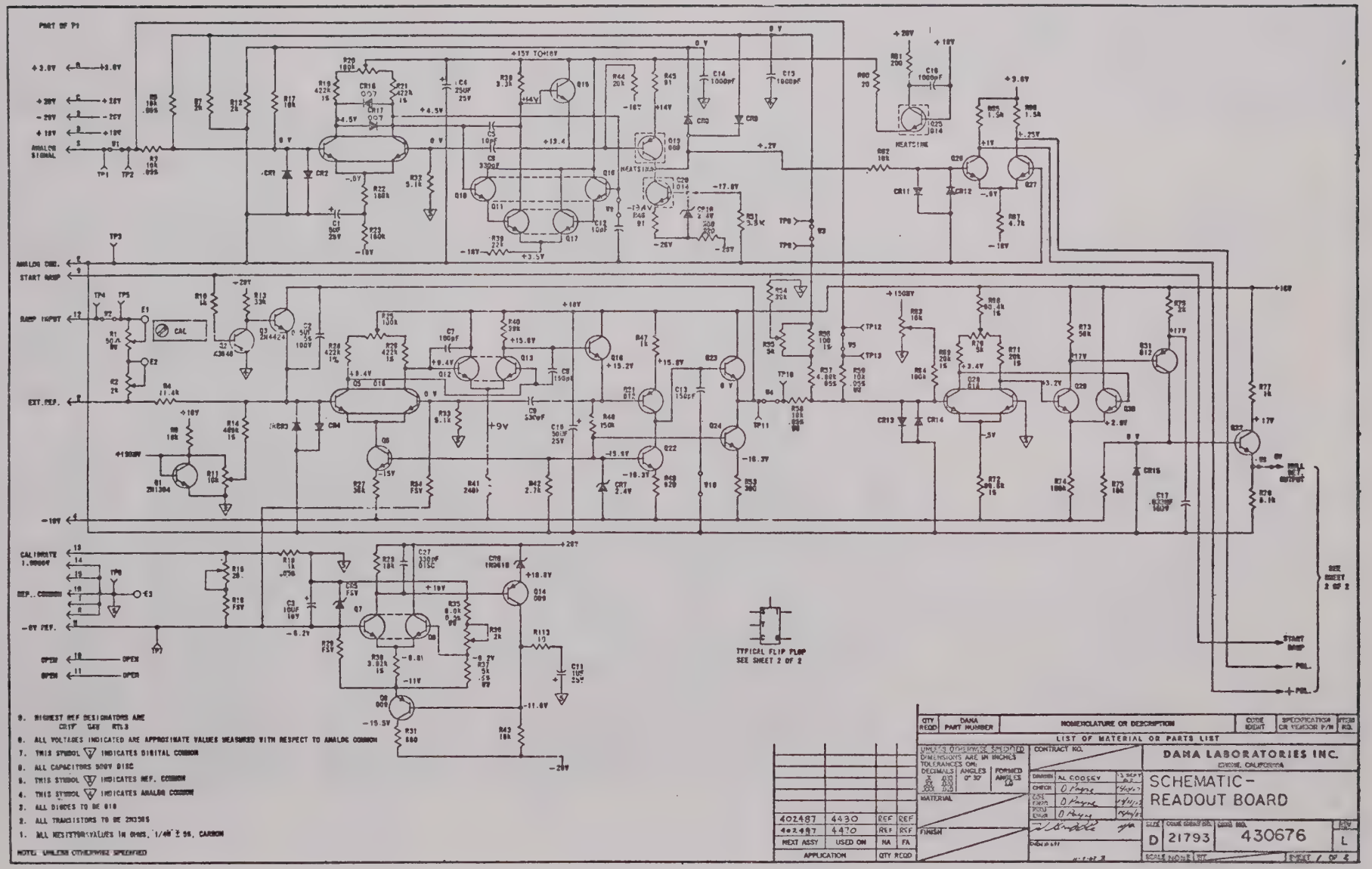
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY READOUT BOARD

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	402487	W

SCALE — SHEET 3 OF 3

NOTES: UNLESS OTHERWISE SPECIFIED



9. HIGHEST REF DESIGNATORS ARE CR19 Q48 R73
8. ALL VOLTAGES INDICATED ARE APPROXIMATE VALUES MEASURED WITH RESPECT TO ANALOG COMMON
7. THIS SYMBOL ▽ INDICATES DIGITAL COMMON
6. ALL CAPACITORS 500V DISC
5. THIS SYMBOL ▽ INDICATES REF. COMMON
4. THIS SYMBOL ▽ INDICATES ANALOG COMMON
3. ALL DIODES TO BE 610
2. ALL TRANSISTORS TO BE 2N3585
1. ALL RESISTOR VALUES IN OHMS, 1/4W ± 5%, CARBON

NOTE: UNLESS OTHERWISE SPECIFIED

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
		LIST OF MATERIAL OR PARTS LIST			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON: DECIMALS .XX ±.02, .XXX ±.005; ANGLES 0° 30'; FRACTIONS ±0

MATERIAL

FINISH

402487	4430	REF	REF
402497	4470	REF	REF
NEXT ASSY	USED ON	MA	FA
APPLICATION		QTY REQD	

CONTRACT NO.

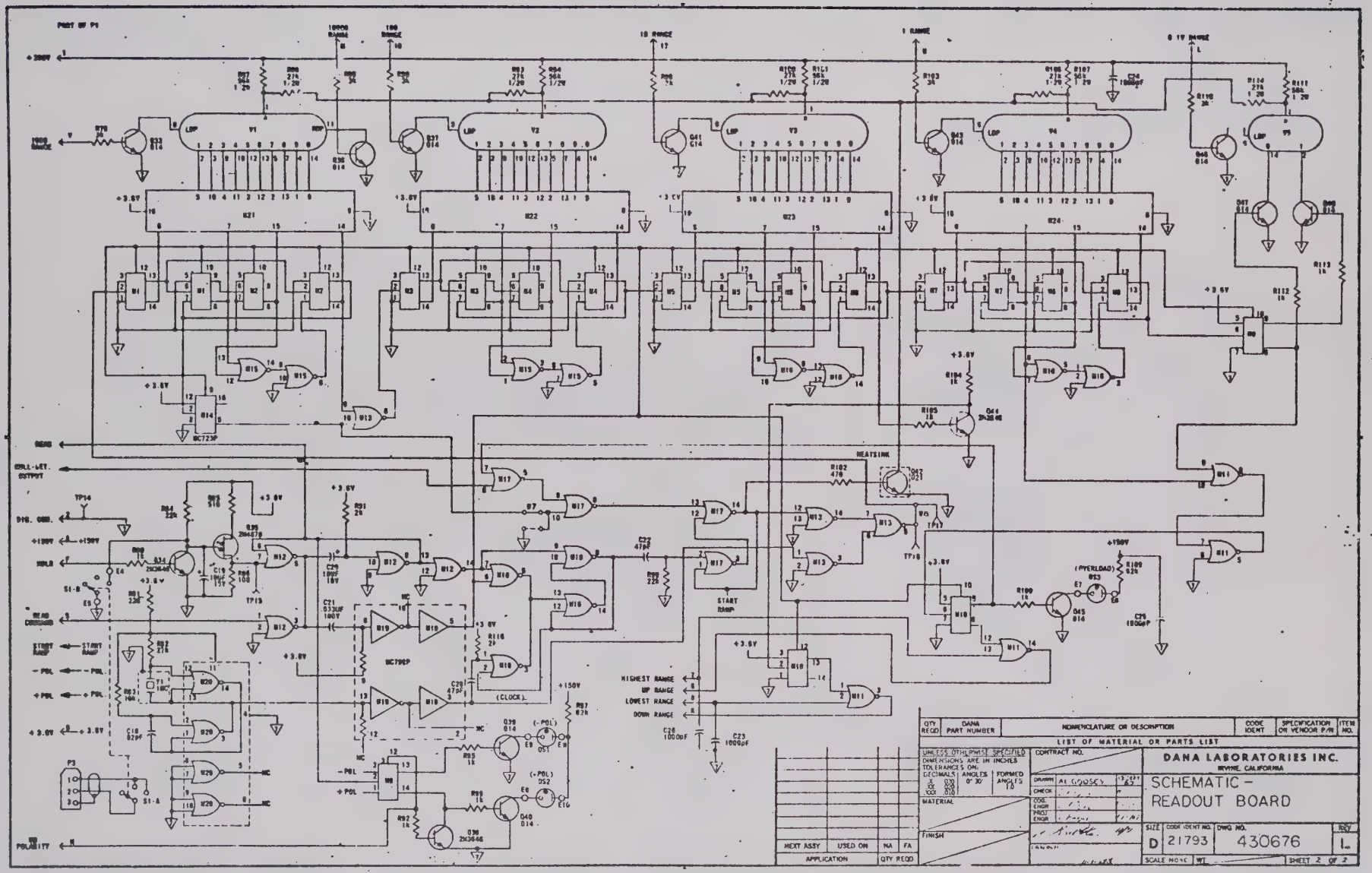
DRAWN	AL COOSEY	3-24-67
CHECK	D Payne	4/4/67
ENGR	D Payne	4/4/67
PROJ ENGR	D Payne	4/4/67
		4-6-67

DANA LABORATORIES INC.
COSTA MESA, CALIFORNIA

SCHEMATIC - READOUT BOARD

SIZE	CAGE CODE NO.	DWG NO.	REV
D	21793	430676	L

SCALE NONE | WT | SHEET 1 OF 4



QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS | ANGLES | FORMED ANGLES
.X ±.030 | 0° 30' | TO
.XX ±.010
.XXX ±.010

MATERIAL

FINISH

CONTRACT NO.

DRAWN AL GOOSEY 12-27-67
CHECK
ENGR
PROJ ENGR

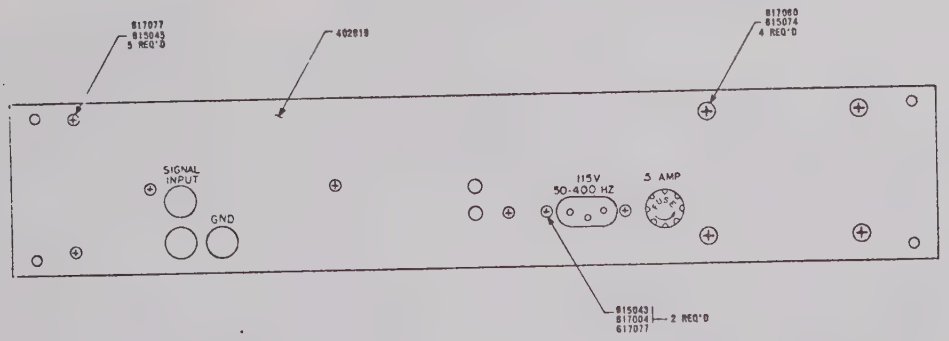
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

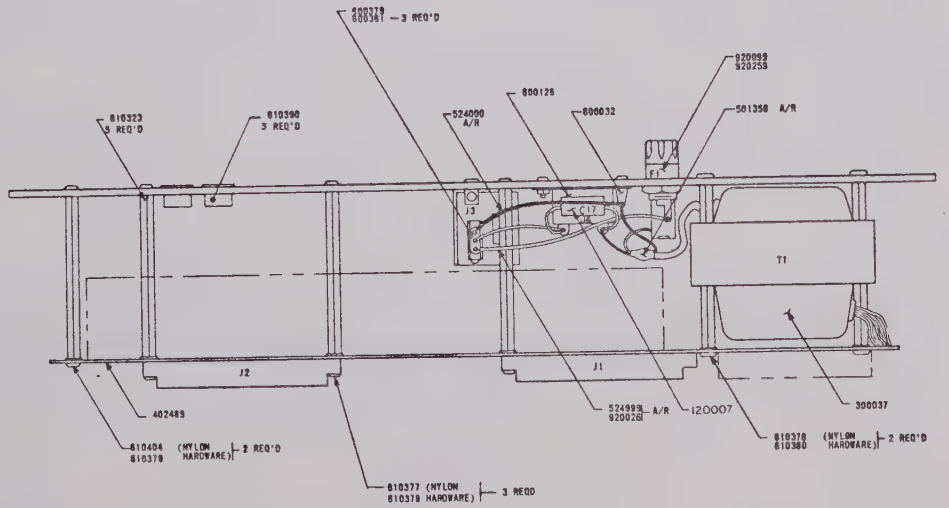
SCHEMATIC - READOUT BOARD

NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQD	

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430676	L

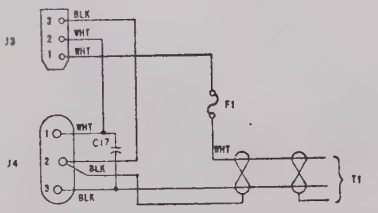
SCALE NONE | WT | SHEET 2 OF 2





WIRE LIST			
402489	E#	COLOR	T1
	2	GY	
	9	BLU	
	3	YLO	
	4	BRN	
	8	GRN	
	6	ORG	
	7	YEL	
	10	BLK	
	5	RED	
402489	1	WHT	T1

WIRING DIAGRAM



QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

POWER SUPPLY ASSY FULL RACK 115V

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	402488	K

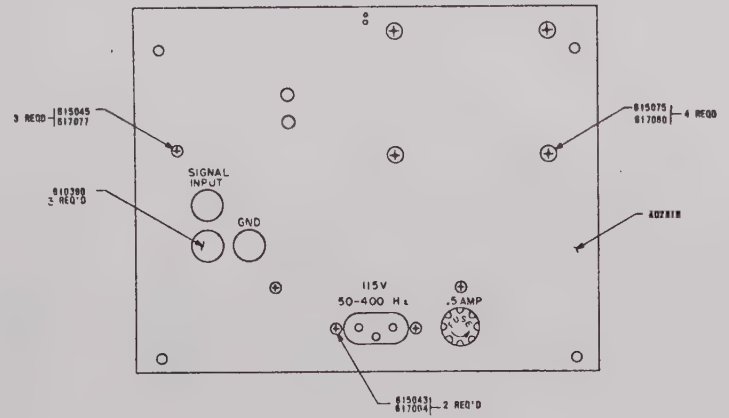
SCALE 1/1 WT SHEET 1 OF 2

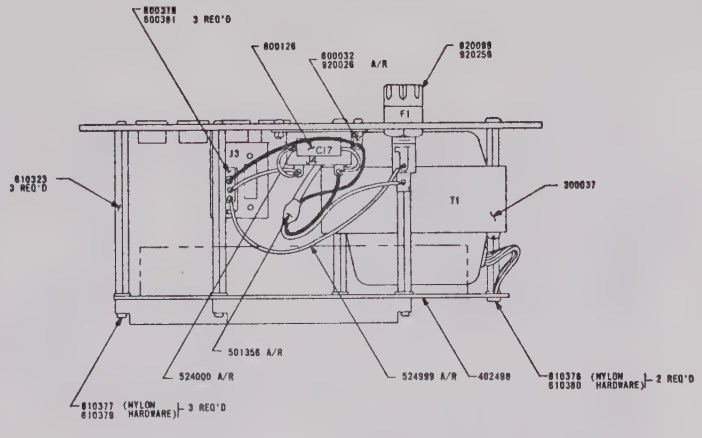
SHT 2 IS AN A SIZE

2. SCHEMATIC REF. NO 430877

1. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.

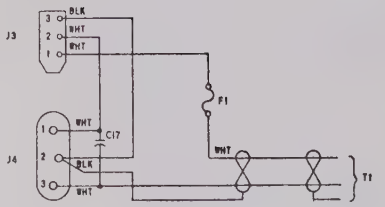
NOTE: UNLESS OTHERWISE SPECIFIED





WIRE LIST			
402498	E#	COLOR	T1
	5	RED	
	9	BLU	
	7	YEL	
	10	BLK	
	3	VIO	
	1	WHT	
	2	GY	
	8	ORG	
	4	BRN	
402498	8	GRN	T1

WIRING DIAGRAM



QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

2. SCHEMATIC REF. NO 430617
1. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS

NOTE: UNLESS OTHERWISE SPECIFIED

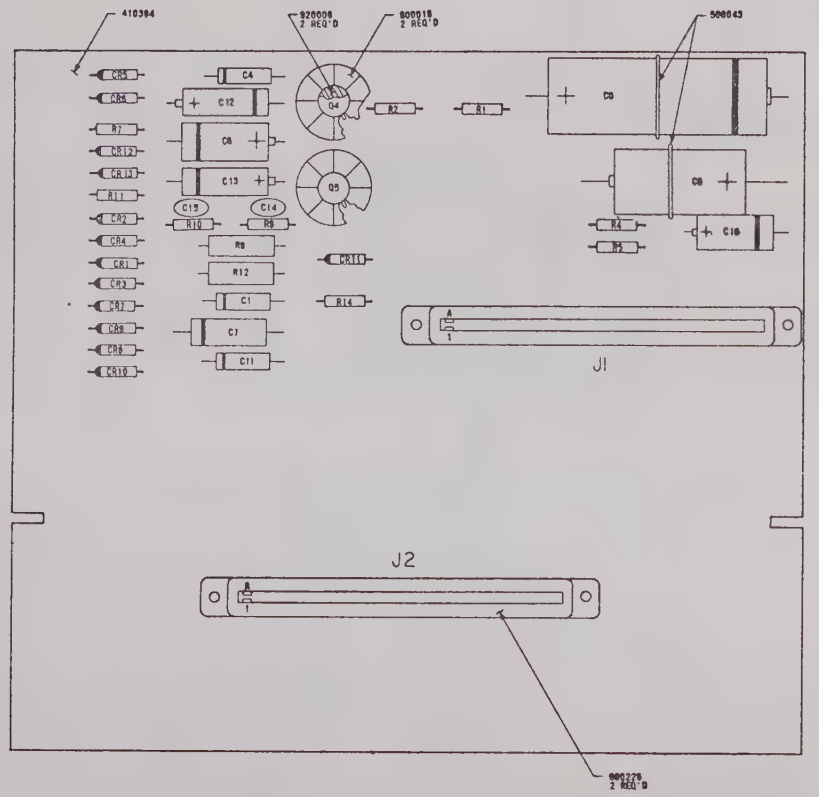
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

POWER SUPPLY ASSY - HALF RACK

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	402497	L

SCALE 1/1 WT SHEET 1 OF 2

SHEET 2 IS AN 'A' SIZE



P/N	DESCRIPTION	QTY
418394	PCB-PWR SUP	1
452498	INSULATOR-MYLAR	1
500832	SHRINK TUBING	
500909	CABLE-SHLD	
500915	TEFLON TUBING	
500843	BUSS WIRE, TEFLON	
503010	HEAT SINK	2
900229	CONNECTOR	2
503273	HEAT SINK	5
010348	RIVET-SEMI TUB 1/16	4
015464	SCREW-PPH 4-40	2
017904	HEX NUT, 4-40	2
017877	LOCKWASHER #6	2
920698	TRANSISTOR PCB-LS	5
920918	SOLDER-BAR	
920829	SOLDER-WIRE	
404472	COMPONENT CLIP	2

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

3. SCHEMATIC REF 430677
2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS
1. ALL RESISTORS ARE 1/4W 5%, CARBON

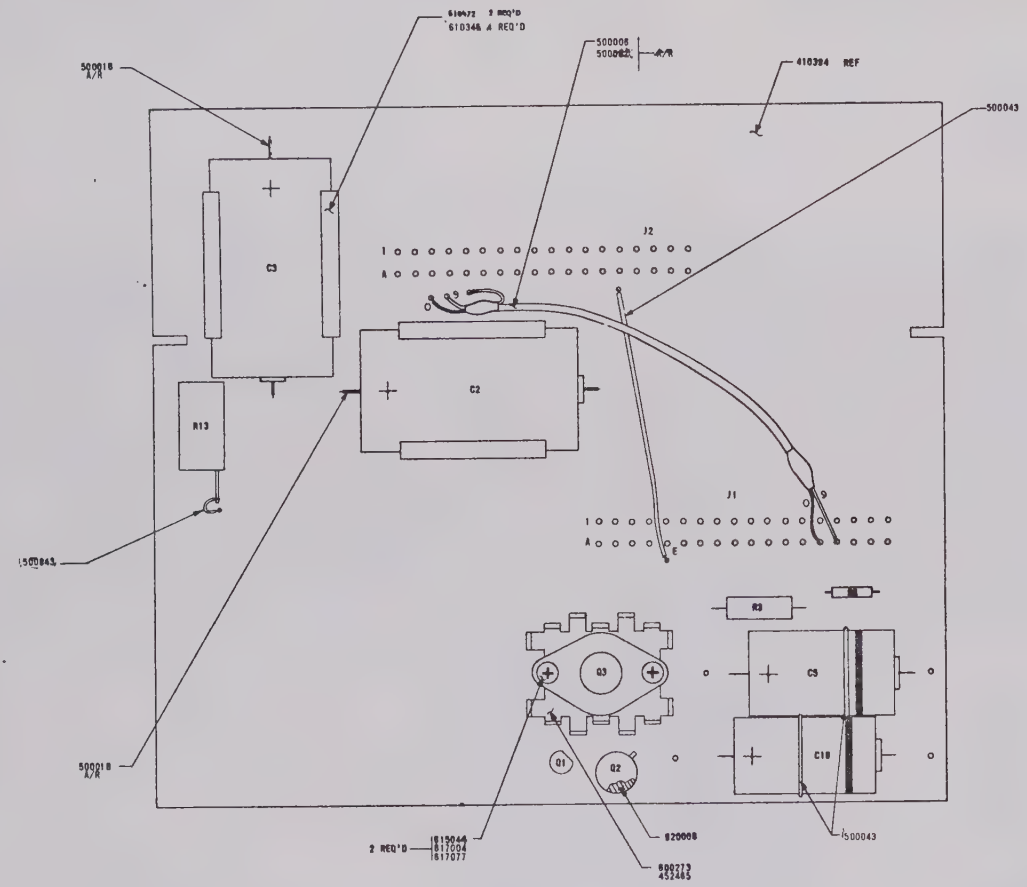
NOTE: UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

PCB ASSY-POWER SUPPLY INTERCONN HALF RACK

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402498	K

SCALE 2 / 1 | WT | SHEET 1 OF 2



CR13	220015	IN967 B			
CR12	220015	IN967 B			
CR11	221177	1/4W2.4A2%			
CR10	210014	823	R14	000511	51Ω
CR9	210014	823	R13	040063	500 /CTS
CR8	210004	SD4	R12	030007	150 3W/WW
			R11	000202	2k
CR1	210004	SD4	R10	000151	150
C16	110077	1000UF/15V	R9	000151	150
C15	101174	.001UF/500V	R8	030007	150 3W/WW
C14	101174	.001UF/500V	R7	000202	2k
C13	110043	25UF/25V	R6	000224	220k
C12	110043	25UF/25V	R5	000751	750
C11	121088	.01UF/100V	R4	000751	750
C10	110083	100UF/12V	R3	030014	220k/1W
C9	110068	15UF/200V	R2	000241	240
C8	110065	20UF-350V	R1	000241	240
C7	120072	.01UF/800V			
C6	110083	100UF-12V			
C5	110085	2000UF/10V	Q5	200011	009
C4	121088	.01UF/100V	Q4	200035	014
C3	110087	7900UF/35V	Q3	200030	RCA40250
C2	110087	2900UF/35V	Q2	200035	014
C1	121088	.01UF/100V	Q1	200043	2N3585
REF DES	PART NO	DESCRIPTION	REF DES	PART NO	DESCRIPTION

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

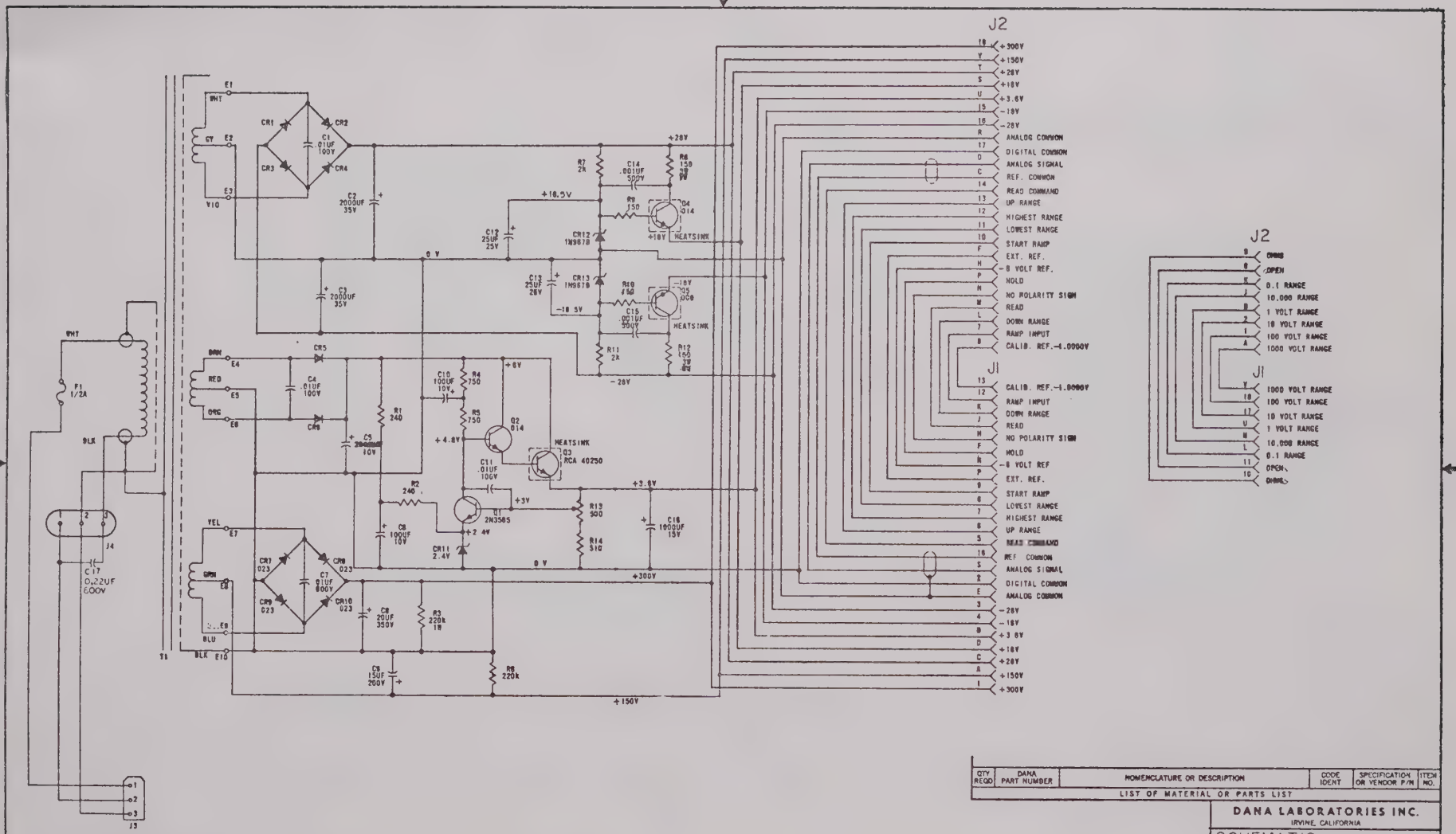
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

PCB ASSY-POWER SUPPLY/INTERCONN, HALF RACK

SIZE	CODE IDENT NO.	DWG NO	REV
D	21793	402498	K

SCALE 2/1 WT SHEET 2 OF 2

NOTE: UNLESS OTHERWISE SPECIFIED



QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

4. ALL VOLTAGES ARE APPROXIMATE VALUES MEASURED WITH RESPECT TO ANALOG COMMON.
3. J1 AND J3 ARE CONNECTED TO THE READOUT BOARD, J2 IS CONNECTED TO THE INPUT MODULE.
2. ALL RESISTOR VALUES IN OHMS, 1/4W ± 5% CARBON.
1. ALL DIODES 504.

NOTE: UNLESS OTHERWISE SPECIFIED

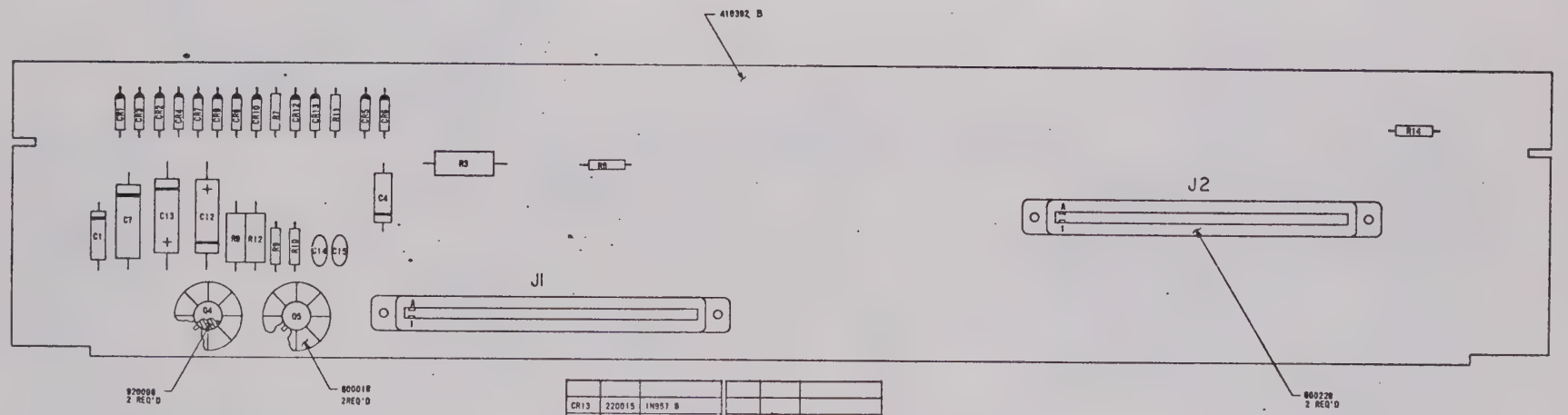
5. HIGHEST REF DESIGNATOR
C17 CR13 Q5 R14

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC -
POWER SUPPLY

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430677	E

SCALE NONE | WT | SHEET 1 OF 1



REF DES	PART NO	DESCRIPTION	REF DES	PART NO	DESCRIPTION
CR13	220015	IN957 B			
CR12	220015	IN987 B			
CR11	221177	1/4W2.4AZ5			
CR10	210014	023	R14	000511	510 Ω
			R13	040063	500 Ω /CTS
CR7	210014	023	R12	030007	150 Ω /3W/WW
CR8	210004	S04	R11	000202	2k
CR1	210004	S04	R10	000151	150 Ω
C16	110077	1000UF/15V	R9	000151	150 Ω
C15	101174	.001UF/500V	R8	030007	150 Ω 3W/WW
C14	101174	.001UF/500V	R7	000202	2k
C13	110043	25UF/25V	R6	000224	220k
C12	110043	25UF/25V	R5	000751	750 Ω
C11	121088	.01UF/100V	R4	000751	750 Ω
C10	110083	100UF/12V	R3	030014	220K/1W
C9	110066	15UF/200V	R2	000241	240 Ω
C8	110065	20UF/350V	R1	000241	240 Ω
C7	120072	.01UF/600V			
C6	110083	100UF/12V			
C5	110085	2000UF/10V	Q5	200011	008
C4	121088	.01UF/100V	Q4	200035	014
C3	110067	2000UF/35V	Q3	200030	RCA40250
C2	110067	2000UF/35V	Q2	200035	014
C1	121088	.01UF/100V	Q1	200043	2N3565

402488	4430	1	1
NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQD	

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
		LIST OF MATERIAL OR PARTS LIST			

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS X .03, XX .020, XXX .010; ANGLES 0° 30'; FORMED ANGLES 1.0
MATERIAL
FINISH
CONTRACT NO.

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

DRAWN	AL GOOSEY	12/12/67
CHECK		
DESIGN	D Payne	12/12/67
PROJ ENGR	D Payne	12/12/67
		12/12/67

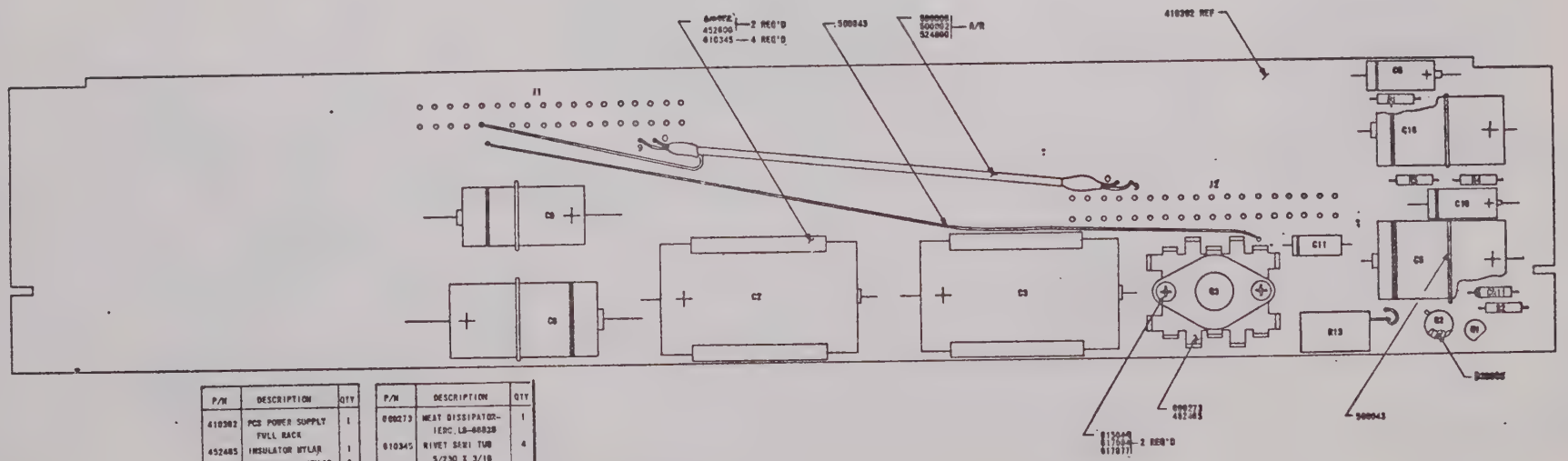
PCB ASSY-POWER SUPPLY/INTERCONN

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	402489	H

SCALE 2/1 WT SHEET 1 OF 2

3. SCHEMATIC REFERENCE: 430877
2. ASSEMBLY PROCESSES AND PROCEDURES TO CONFORM TO DANA WORKMANSHIP STANDARDS.
1. ALL RESISTORS TO BE 1/4W,5%, CARBON

NOTE: UNLESS OTHERWISE SPECIFIED



P/N	DESCRIPTION	QTY
410302	PCB POWER SUPPLY FULL RACK	1
452485	INSULATOR MYLAR	1
452600	INSULATOR - MYLAR, COMP-CLIP	2
500002	TUBING-SHRINK .153 ID	A/R
500000	CABLE-STORM 8-24-18/36N-S2Y	A/R
500043	WIRE-24GAGE WHITE TEFLON COATED	A/R
524000	WIRE-24GAGE BLK	A/R
600010	HEAT SINK IERC TZBF-032-025B	2
600226	CONN-EDGETYPE #252-18-30-180	2

P/N	DESCRIPTION	QTY
600273	HEAT DISSIPATOR-IERC LB-60828	1
610345	RIVET SEMI TUB 5/230 X 3/16 LG AL	4
615044	SCREW PPH 4-40 X 3/8 PPH	2
617004	HEX NUT 4-40 STD STLS	2
617077	WASHER INT LOCK 4 STLS	2
629000	TRANS PAD-LARGE	3
920510	SOLDER-63/37 BAR	A/R
920028	SOLDER-WIRE .032363/37 RESIN CORE	A/R
510432	CLIP COMPONENT SEASTRUM	2

NOTE: UNLESS OTHERWISE SPECIFIED

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
		LIST OF MATERIAL OR PARTS LIST			

402488	4430	1	1
NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS ANGLES ± 30' FORMED ANGLES ±1°
MATERIAL
FINISH

CONTRACT NO.

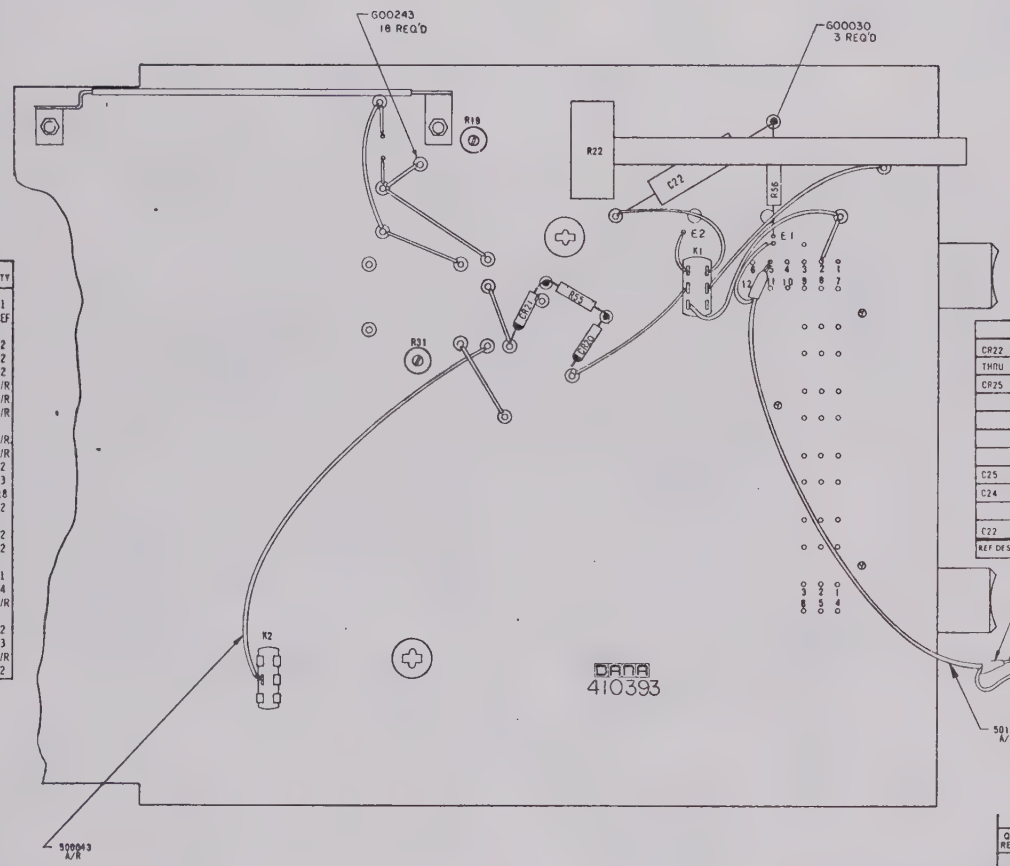
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

DRAWN	AL GOOSEY	4/24/72
CHECK		
DESIGN	D Pastore	4/24/72
PROJ ENGR	D Pastore	4/24/72

PCB ASSY - POWER SUPPLY / INTERCONN

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402489	H

SCALE 2/1 WT SHEET 2 OF 2



P/N	DESCRIPTION	QTY
410393	PCB ISOLATOR	1
430678	SCHEM CONT MODULE	REF
452144	NYLON STANDOFF	2
452747	SHIELD-ISOLATOR	2
452770	INSULATOR-SHIELD	2
500002	SHRINK TUBING	A/R
500037	WIRE-BUSS 24 GA	A/R
500043	WIRE-24 GA WHT TEFLON COATED	A/R
501356	SHRINK TUBING	A/R
501446	CABLE-RG174/U	A/R
600026	LUG-SOLDER	2
600030	TERM-TEFLON	3
600243	TERM-FEEDTHRU	18
615014	SCREW PPH 2-56 X 1/4	2
617002	NUT, HEX 2-56	2
617075	WASHER-INT LOCK NO. 2 STLS	2
617101	WASHER-FLAT	1
920006	TRANS PAD-LARGE	4
920008	CEMENT-EASTMAN 910	A/R
920010	SOLDER-63/37 BAR	2
920018	BUT-PLUG	3
920026	SOLDER-WIRE	A/R
920082	TRANS PAD-DUAL	2

CR12	211083	D18
CR11	211083	D18
CR10	211083	D18
CR9	211083	D18
CR8	211236	D07
CR7	211236	D07
CR6	220004	1N961B
CR5	211236	D07
CR4	211236	D07
CR3	220016	1N964B
CR2	220016	1N964B
CR1	211083	D18
C20	120134	1UF/200V
C19	110071	1UF 35V
C18	101099	680PF, DISC
C17	121468	.022UF/100V
C16	110047	50UF/25V
C15	110047	50UF/25V
C14	110071	1UF 35V
C13	101145	100PF DISC
C12	101145	100PF DISC
C11	120153	47pF 125V
C10	.120137	56UF 200V
C9	120135	.015uF, 33V
C8	120011	068UF/100V
C7	120178	27 UF/50V
C6	110043	25UF, 25V
C5	101182	47pF, DISC
C4	110085	47UF, 6V
C2	120177	.56UF/50V
C1	110070	22UF 6V
REF DES	PART NO	DESCRIPTION

CR22	211083	D18
THRU		
CR25	211083	D18
C25	101175	220PF DISC
C24	101175	220PF DISC
C22	120186	1000 PF/1000V
REF DES	PART NO	DESCRIPTION

R1	000102	1k
Q20	200035	D14
Q19	200043	2N3585
Q18	200022	D12
Q17	200043	2N3585
Q16	200022	D12
Q15	200035	D14
Q14	200043	2N3585
Q13	201084	2N1304
Q12	200011	D09
Q11	200043	2N3585
Q10	200068	2N4250
Q9	200040	D18
Q8	200040	D18
Q7	200037	2N3648
Q6	200036	D15
Q5	200043	2N3585
Q4	200043	2N3585
Q3	200043	2N3585
Q2	200043	2N3585
Q1	200035	D14
M4	230000	MC724
M3	230003	MC790P
M2	230000	MC724P
M1	230000	MC724P
CR21	220004	1N961B
CR20	220004	1N961B
CR19	211083	D18
CR18	220022	1N965B
CR17	220022	1N965B
CR16	211083	D18
CR15	211083	D18
CR14	211083	D18
REF DES	PART NO.	DESCRIPTION

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
		LIST OF MATERIAL OR PARTS LIST			

402492	210	1	1	
NEXT ASSY	USED ON	NA	FA	
APPLICATION		QTY REQD		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS: X .030, XX .010, XXX .010; ANGLES 0° 30'; FORMED ANGLES 1.0

CONTRACT NO.

MATERIAL

FINISH

DRAWN 10-17-67

CHECK 10/18/67

DESIGN 11/1/67

PROJ ENGR 11/1/67

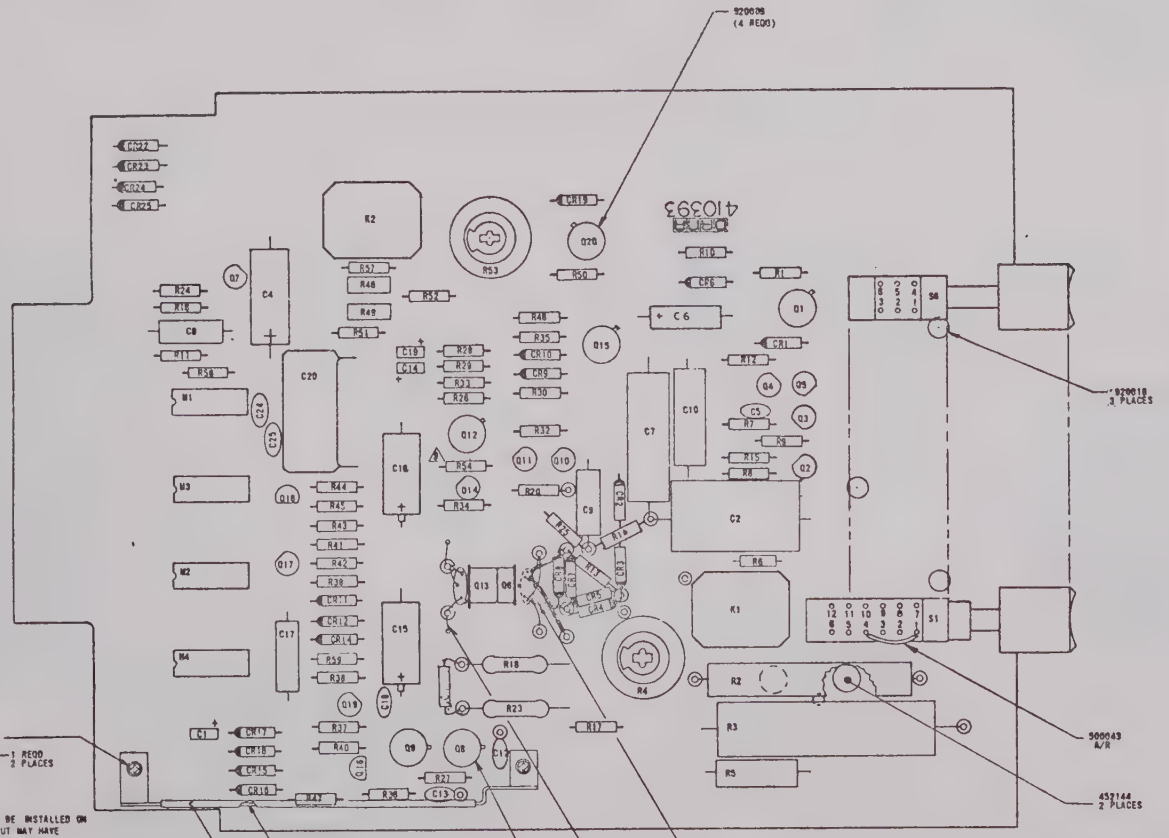
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSEMBLY —
DC ISOLATOR 210

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402493	N

SCALE 2:1 WT. SHEET 1 OF 2

NOTE, UNLESS OTHERWISE SPECIFIED



REF DES	PART NO.	DESCRIPTION
R35	000271	270
R34	000512	5.1k
R33	000301	300
R32	000432	4.3k
R31	040087	10k POT.
R30	000513	51k
R29	000123	12k
R28	000101	100
R27	000104	100k
R26	000184	180k
R25	000518	5.1 MEG
R24	000107	1k
R23	010337	10 MEG 1%
R22	040100	500k POT.
R20	000755	7.5 MEG
R19	040088	1 MEG POT
R18	010337	10 MEG 1%
R17	000244	240Ω NOMINAL
R16	000102	1k
R15	000513	51k
R14	010058	20k 1%
R13	000103	10k
R12	000912	9.1k
R11	000154	150k
R10	000202	2k
R9	000295	2 MEG
R8	000513	51k
R7	000514	510k
R6	000513	51k
R5	010334	38.75k Ω 1%
R4	040062	500 POT
R3	010334	9.9997K Ω 1%
R2	030015	100k 1% 10W

REF DES	PART NO.	DESCRIPTION
K2	310021	RELAY
K1	310029	RELAY
S1	000336	SWITCH
THRU		
S8	000336	SWITCH
R58	000151	150
R58	000511	510
R57	000102	1k
R58	000102	1k
R55	000102	1k
R54	001734	270Ω MOM
R53	040053	5k POT
R52	000153	15k
R51	000514	510k
R50	000102	1k
R49	022704	1 1111k .05%
R48	020241	10k 05%
R47	000103	10k
R46	000101	100
R45	000102	1k
R44	000820	82
R43	000820	82
R42	000102	1k
R41	000432	4.3k
R40	000102	1k
R39	000153	15k
R38	000912	9.1k
R37	000513	51k
R36	000202	2k

⚠ A 270 OHM RESISTOR CAN BE INSTALLED ON THE INITIAL ASSEMBLY BUT MAY HAVE TO BE CHANGED IN A FEW CASES.

8. DO NOT HUMI-SEAL THIS ASSEMBLY
7. CEMENT Q13 AND Q8 TOGETHER WITH EASTMAN 910 920008
6. ALL RESISTORS ARE VALUED IN OHMS ± 5% CARBON
5. ALL DIODE ARE 619
4. DO NOT MOUNT SWITCH ASSEMBLY, K1, K2, C7 AND C9 UNTIL AFTER BOARD HAS BEEN CLEANED
3. ALL ASSEMBLIES AND PROCEDURES TO CONFORM WITH DANA WORKMANSHIP STANDARDS
2. ALL RESISTOR VALUES ARE IN OHMS ±5% 1/4W CARBON
1. SCHEMATIC REFERENCE: 430878

NOTE: UNLESS OTHERWISE SPECIFIED

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS .XX ±.03, .XXX ±.010; ANGLES 0° 30'; FORMED ANGLES 1.0

MATERIAL

FINISH

CONTRACT NO.

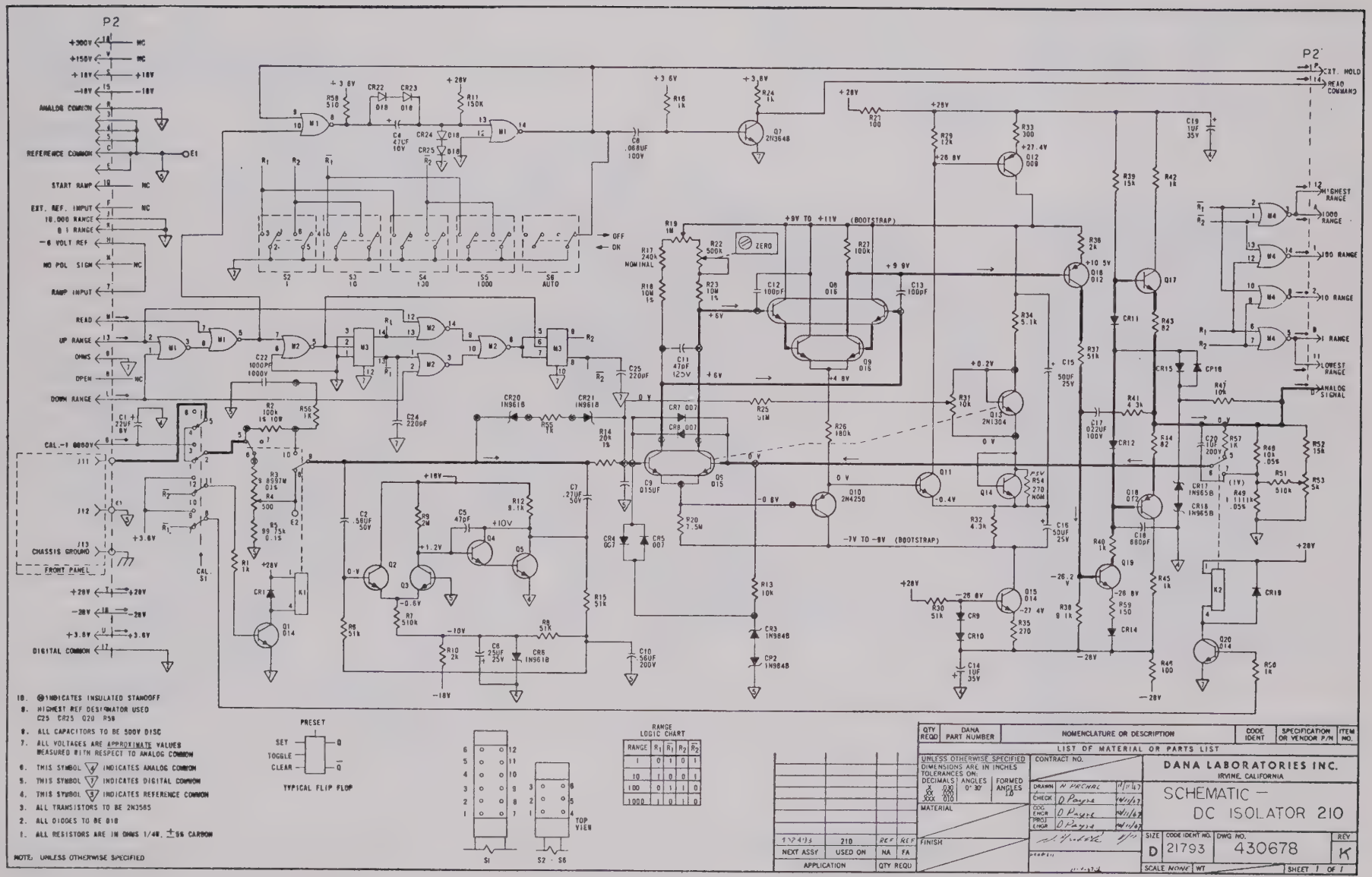
DRAWN	[illegible]	10-19-67
CHECK	[illegible]	11/3/67
DESIGN	[illegible]	11/3/67
PROJ ENGR	[illegible]	11/3/67
	[illegible]	11/3

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSEMBLY — DC ISOLATOR

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402493	N

SCALE 2 : 1 | WT | SHEET 2 OF 2



QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS ANGLES FORMED ANGLES .X ±.02 ±0° 30' .XX ±.010 .XXX ±.005 MATERIAL FINISH

CONTRACT NO.

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

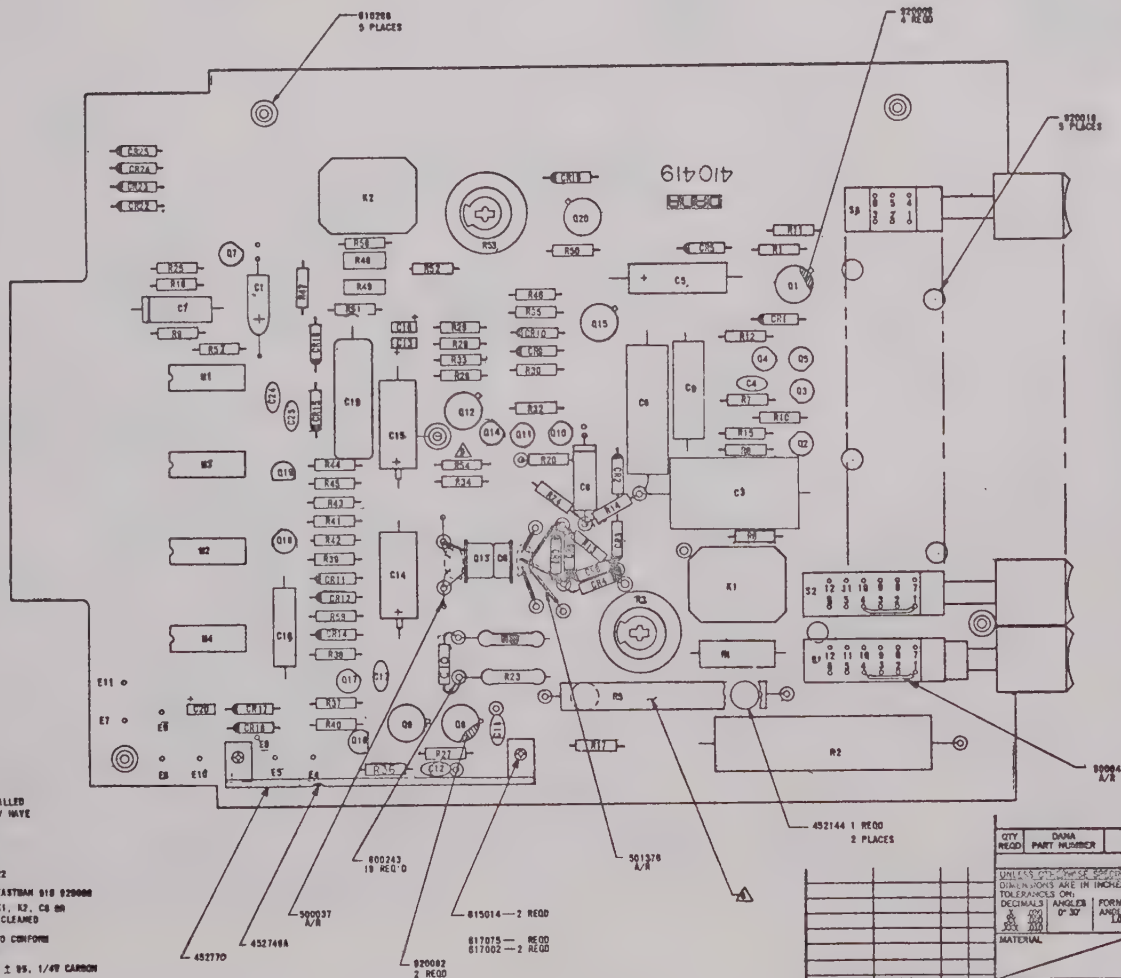
DRAWN	H HECHAL	4/11/67
CHECK	D Payne	4/11/67
ENGR	D Payne	4/11/67
PROJ ENGR	D Payne	4/11/67

SCHEMATIC — DC ISOLATOR 210

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430678	K

SCALE NONE WT SHEET 1 OF 1

17243	210	REF	REF
NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQU	



REF DES	PART NO.	DESCRIPTION
CR22 THRU CR25	211083	018
CR24	211082	018
CR20 THRU CR23	211083	018
CR12	211083	018
CR9 THRU CR11	211236	007
CR8	211238	007
CR5	220004	1N9618
CR4	211263	007
CR3	220018	1N9448
CR2	220018	1N9448
CR1	211083	018
C25	101175	220pF DISC
C24	101175	220pF DISC
C22	120184	.001/1000V
C20	110078	22 MF/6V
C19	120134	1MF, 250V
C18	110071	1MF 35V
C17	101009	2200F, DISC
C16	121468	8220UF, 100V
C15	110047	200F, 25V
C14	110047	50UF, 25V
C13	110071	1UF, 35V
C12	101145	1000f, DISC
C11	101145	100pF, DISC
C10	129153	47pF 125V
C9	120137	0.56UF, 200V
C8	120135	.015UF, 33V POLY
C7	120011	.068UF 100V
C6	120138	.27UF, 50V
C5	110043	250F, 25V
C4	101102	47pF
C3	120177	56UF, 50V
C1	110096	47UF/6V

REF DES	PART NO.	DESCRIPTION
X2	810334	9.999791, 8.15
R1	809162	1R
Q20	200035	014
Q19	200022	012
Q18	200043	2N3563
Q17	200043	2N3565
Q16	200022	012
Q15	200035	014
Q14	200043	2N3563
Q13	200046	2N1584
Q12	200011	9C8
Q11	200043	2N3565
Q10	200080	2N4250
Q9	200040	010
Q8	200040	010
Q7	200037	2N3548
Q6	200027	015 SELECTED
Q5	200043	2N3565
Q4		
Q3		
Q2	200043	2N3563
Q1	200035	014
U4	230070	MC724P
U3	230003	MC789P
U2	230000	MC724P
U1	230000	MC724P
CR21	220004	1N9618
CR20	220004	1N9618
CR19	211083	018
CR18	220022	1N9633
CR17	220022	1N9658
CR16	211083	018
CR15	211083	018

⚠ A 270 OHM RESISTOR CAN BE INSTALLED ON THE INITIAL ASSEMBLY BUT MAY HAVE TO BE CHANGED ON A FEW CASES

8. DO NOT SEMI-SEAL THIS ASSY.

⚠ ASSEMBLE RS AFTER ASSEMBLING A22

9. CEMENT Q13 & Q8 TOGETHER WITH EASTMAN 910 029000

4. DO NOT MOUNT SWITCH ASSEMBLY, X1, X2, C8 OR C10 UNTIL AFTER BOARD HAS BEEN CLEANED

3. ALL ASSEMBLIES AND PROCEDURES TO CONFORM WITH DANA WORKMANSHIP STANDARDS

2. ALL RESISTOR VALUES ARE IN OHMS ± 5%, 1/4W CARBON

1. SCHEMATIC REFERENCE: 430685

NOTE: UNLESS OTHERWISE SPECIFIED

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
		LIST OF MATERIAL OR PARTS LIST			

402544	220	1	1
NEXT ASSY	USED ON	MA	FA
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS .XX ±.02, .XXX ±.010; ANGLES 0° 30'; FORMED ANGLES 1.0

MATERIAL

FINISH

CONTRACT NO.

DRAWN Jim Cartwright 10-17-67

CHECK T. Hamlin 10-27-67

DESIGN D. Hamm 11-1-67

PROJ ENGR D. Hamm 11-1-67

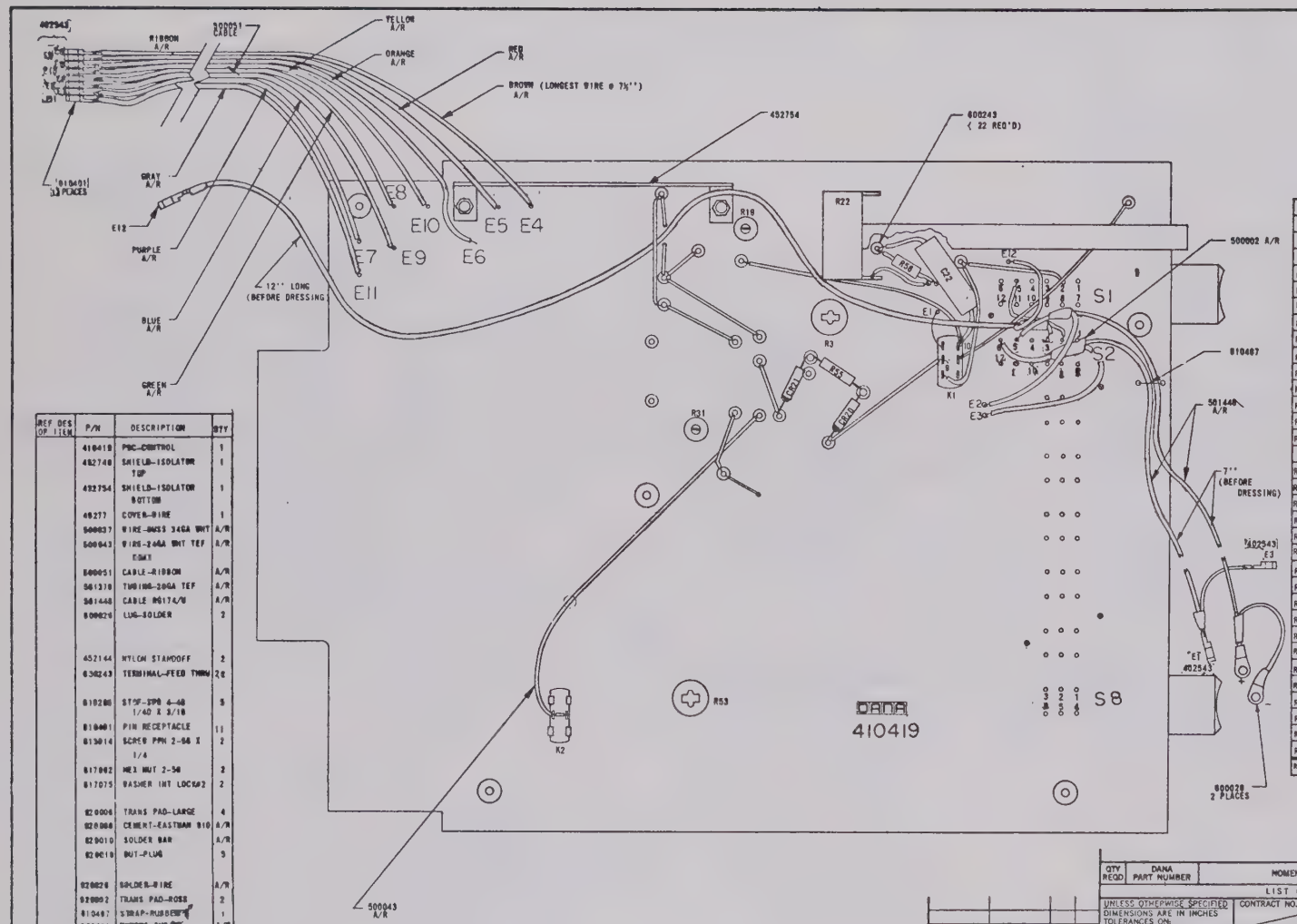
APPD W. Riddle 11-6-67

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSEMBLY — 220
AC/DC ISOLATOR

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402515	F-U

SCALE 2/1 WT SHEET 1 OF 2



REF DES OR ITEM	P/N	DESCRIPTION	QTY
	410419	PSC-CONTROL	1
	452740	SHIELD-ISOLATOR TOP	1
	452754	SHIELD-ISOLATOR BOTTOM	1
	49277	COVER-WIRE	1
	500037	WIRE-BUSS 24GA WHT	A/R
	500043	WIRE-24GA WHT TEF EQUI	A/R
	600051	CABLE-RIBBON	A/R
	561378	TWB18G-20GA TEF	A/R
	561448	CABLE RG174/U	A/R
	600028	LUG-SOLDER	2
	452144	NYLON STANDOFF	2
	636243	TERMINAL-FEED THRU	22
	810288	STSF-SP0 4-40 1/40 X 3/16	5
	810401	PIN RECEPTACLE	11
	813014	SCREW PPN 2-56 X 1/4	2
	817002	NEX NUT 2-56	2
	817075	WASHER INT LOCK#2	2
	820006	TRANS PAD-LARGE	4
	820008	CEMENT-EASTMAN 910	A/R
	829010	SOLDER BAR	A/R
	829018	BUT-PLUG	3
	920028	SOLDER-WIRE	A/R
	920002	TRANS PAD-ROSS	2
	810487	STRAP-RUBBER	1
	500002	PIPING-3MR BLK	A/R

REF DES	PART NO	DESCRIPTION
R36	000202	2k
R35	000271	270
R34	000512	5.1k
R33	000301	300
R32	000432	4.3k
R31	040087	10k POT
R30	000513	51k
R29	000123	12k
R28	000101	100
R27	000104	100k
R26	000184	180k
R25	000102	1k
R24	000516	51M
R23	010337	10 M 1%
R22	040100	500k POT
R20	000755	7.5M
R19	040099	1 M POT
R18	010337	10 M 1%
R17	000244	FSV (NOW 240k)
R16	000102	1k
R15	000513	51k
R14	010059	20k 1%
R13	000103	10k
R12	000912	9.1k
R11	000202	2k
R10	000205	2 M
R9	000154	150k
R8	000513	51k
R7	000514	510k
R6	000512	5.1k
R5	030015	100k 1% 10T
R4	010334	39.75k @ 1%
R3	040087	500 POT

REF DES	PART NO	DESCRIPTION
K2	310021	RELAY
K1	310029	RELAY
S1	600337	SWITCH
THRU		
S8	600337	SWITCH
R58	000151	150
R58	000102	1k
R57	000511	510
R56	000103	10k
R55	000102	1k
R54	001734	270Ω MOX
R53	040059	5k POT.
R52	000153	15k
R51	000514	510k
R50	000102	1k
R49	020204	1.1111k .05%
R48	020241	10k .05%
R47	000103	10k
R46	000101	100
R45	000102	1k
R44	000820	82
R43	000820	82
R42	000102	1k
R41	000422	4.3k
R40	000102	1k
R39	000153	15k
R38	000912	9.1k
R37	000513	51k

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
402544	220 DI	1	1		
NEXT ASSY	USED ON	N/A	FA		
APPLICATION		QTY REQD			

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS .XX ±.03, .XXX ±.010; ANGLES 0° 30'; FORMED ANGLES ±.0

MATERIAL

FINISH

CONTRACT NO.

DRAWN	Jim Ontiveros	10-17-67
CHECK	W. Nudelman	10/19/67
DESIGN	D Payne	10/16/67
PROJ ENGR	D Payne	10/16/67

W Nudelman 11/20

ORN # 723

1-20-68 Rev

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

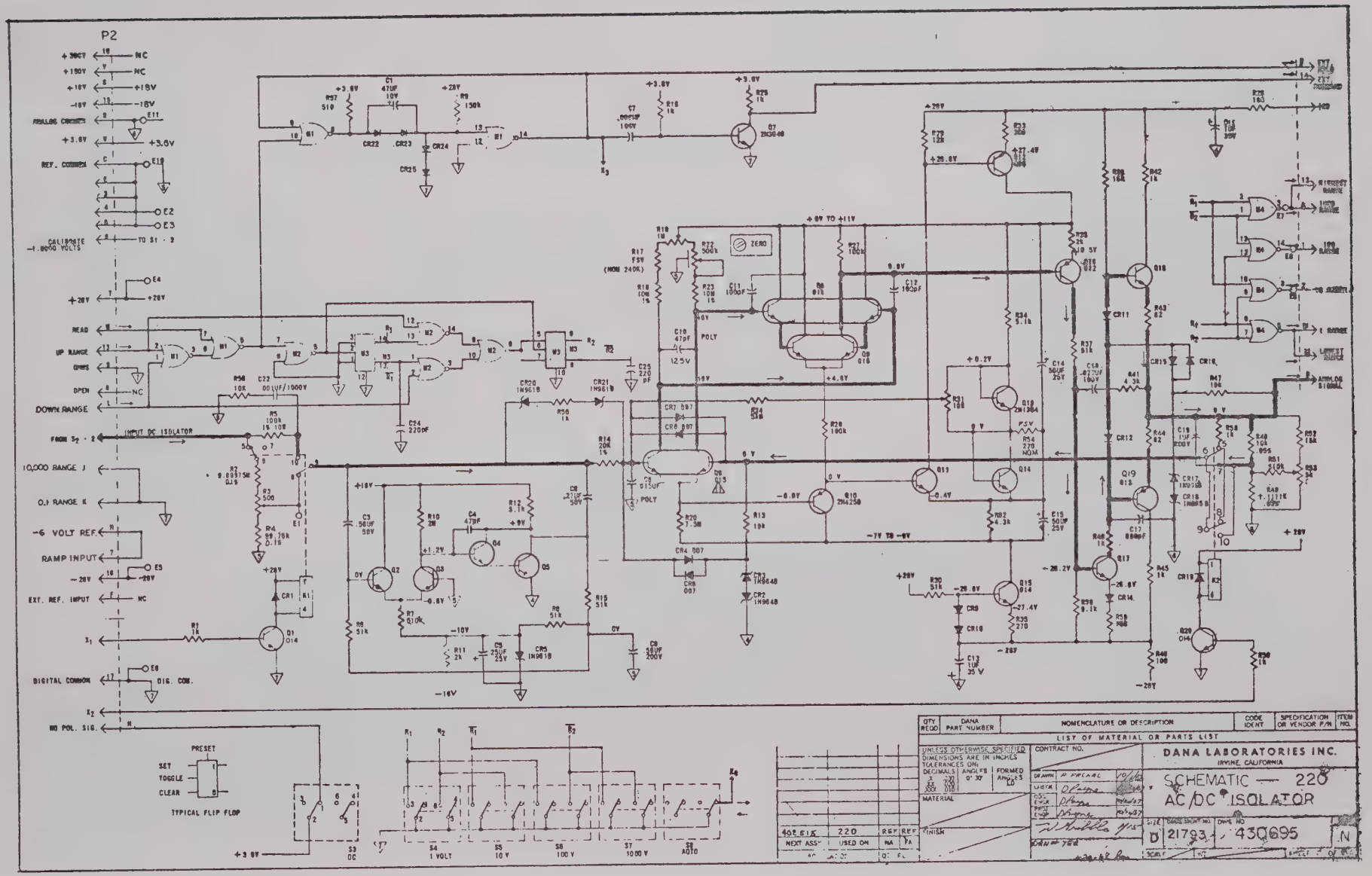
ASSEMBLY — 220
AC/DC ISOLATOR

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402515	J

SCALE 2/1 WT SHEET 2 OF 2

SEE SHEET 1

NOTE: UNLESS OTHERWISE SPECIFIED



QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS ANGLES 0° 30' FORMED .XX ±.02 .XXX ±.010 BENDS 1.0

MATERIAL

FINISH

402 615 | 220 | REF | REF

NEXT ASSY | USED ON | NA | FA

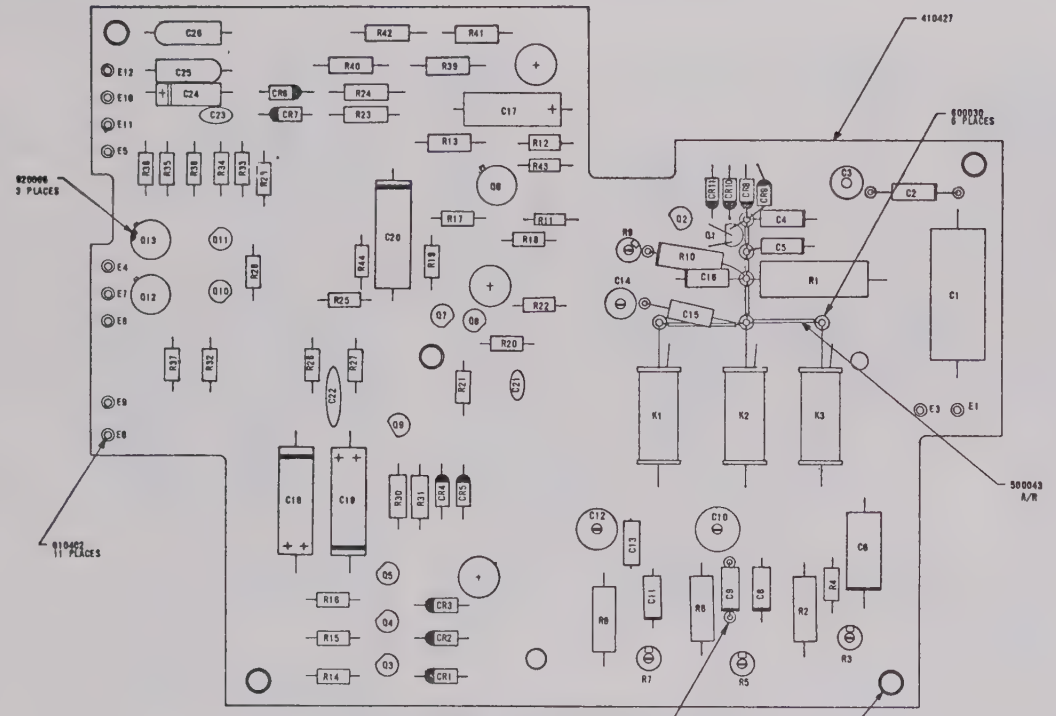
CONTRACT NO.

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC — 220
AC/DC ISOLATOR

SIZE D | DANA DRAWING NO. 21793 | DANA NO. 430695 | N

SCALE | WT. | SHEET 1 OF 1



REF DES	PART NUMBER	DESCRIPTION
CR4	220015	1N9678
CR3	211083	018
CR2	211083	018
CR1	211083	018
C28	110022	3.3UF/35V
C25	110022	3.3UF/35V
C24	110005	10UF/50V
C23	101145	100pF
C22	100021	82pF
C21	101145	100pF
C20	121393	22UF/100V
C19	110047	50UF/25V
C18	110047	50UF/25V
C17	111148	100UF/25V
C16	120163	15pF/63V
C15	120142	FSV 0 TO 1000PF
C14	130054	1-5pF TRIMMER
C13	120034	100pF/500V
C12	130055	5-80pF TRIMMER
C11	120158	390pF/63V, 1%
C10	130055	5-80pF TRIMMER
C9	120142	FSV 0 TO 1000pF
C8	120182	.0044/63V
C7	120181	.047UF/63V
C6	120197	200F/1000V
C5	120138	20pF/630V
C4	130054	1-5pF TRIMMER
C3	130054	1-5pF TRIMMER
C2	120142	FSV 0 TO 1000pF
C1	120007	.22UF/600V

REF DES	PART NUMBER	DESCRIPTION
R12	000332	3.3k
R11	000104	100k
R10	010341	.995 MEG .1% *
R9	040048	20k POT
R8	010341	55.25k .1% *
R7	040123	1k POT
R6	010341	5.000k .1% *
R5	040110	100 POT
R4	000273	27k
R3	040104	50k POT
R2	010341	507Ω .1% *
R1	010341	1 MEG .1% *
Q13	200035	014
Q12	200031	060
Q11	200060	2N4250
Q10	200043	2N3585
Q9	200022	012
Q8	200080	2N3585-SELECTED
Q7	200080	2N3585-SELECTED
Q6	200057	060
Q5	200037	2N3848
Q4	200037	2N3848
Q3	200037	2N3848
Q2	200022	012
Q1	200085	2N5457
CR11	221177	1/4W2 4AZ5
CR10	221177	1/4W2.4AZ5
CR9	211236	007
CR8	211236	007
CR7	211083	018
CR6	211083	018
CR5	220015	1N9678

REF DES	PART NUMBER	DESCRIPTION
K3	310036	SPST 24V RELAY
K2	310035	SPST 24V RELAY
K1	310035	SPST 24V RELAY
R44	000105	1 MEG
R43	000201	200
R42	010060	10k, 1%
R41	010341	2k, 0.1% *
R40	010060	10k, 1%
R39	010341	2k, 0.1% *
R38	000331	330
R37	000331	330
R36	000101	100
R35	000332	3.3k
R34	000101	100
R33	000101	100
R32	000332	3.3k
R31	001712	750, 1/2W
R30	001712	750, 1/2W
R29	000103	10k
R28	000751	750
R27	000512	5.1k
R26	000332	3.3k
R25	000106	10M
R24	010341	4.442k 0.1% *
R23	010341	4.442k 0.1% *
R22	000203	20k
R21	000104	100k
R20	000104	100k
R19	000106	10M
R18	000752	7.5k
R17	000104	100k
R16	000102	1k
R15	000102	1k
R14	000102	1k
R13	010341	1.135k .1% *

* INDICATES RESISTOR SET

P/N	DESCRIPTION	QTY
410427	PCB-CONVERTER AC/DC	1
500043	BUSS WIRE	A/R
600030	TERMINAL	8
600287	CONN-PC JACK CARRION	8
810402	FORMED PIN	11
810273	STOF-SWG, SPACER	5
820008	TRANS PAD-LARGE	3
820029	SOLDER-WIRE RESIN CORE	A/R

3. ALL ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS
2. ALL RESISTORS ARE VALUED IN OHMS, 1/4W, 5%, CARBON
1. SCHEMATIC REFERENCE: 430005

NOTE: UNLESS OTHERWISE SPECIFIED

402510	220	1	1
NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQD	

QTY REQD | DANA PART NUMBER | NOMENCLATURE OR DESCRIPTION | CODE IDENT | SPECIFICATION OR VENDOR P/N | ITEM NO.

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON: DECIMALS .XX ±.030, .XXX ±.010; ANGLES 0° 30'; FORMED ANGLES 1.0

MATERIAL

FINISH

CONTRACT NO.

DRAWN Jim Antista 11-20-84

CHECK A. Blanchette 11-20-84

DESIGN

PROJ ENGR O.K. 12/6/84

DWG # 125

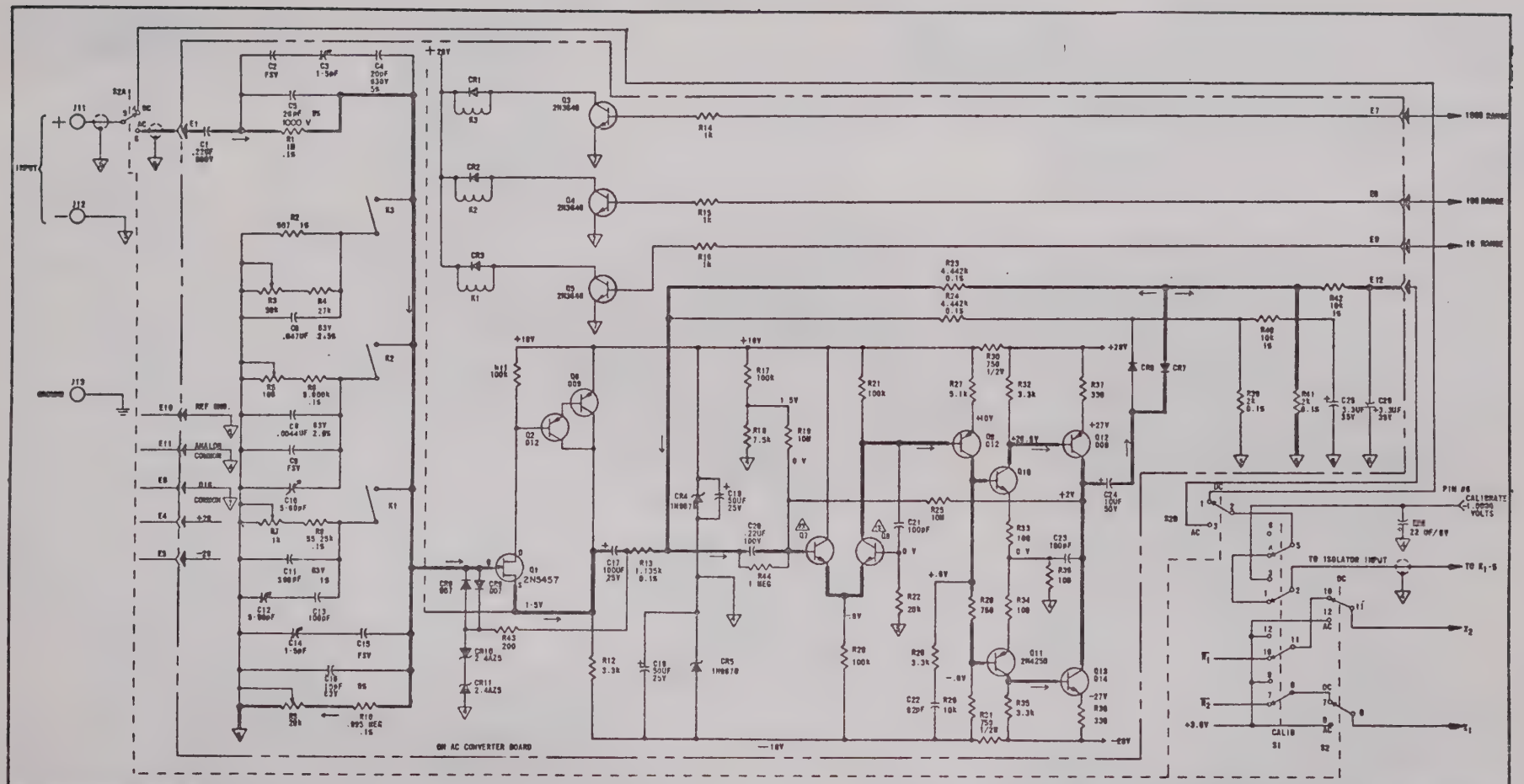
1-20-84

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSEMBLY — 220 AC/DC CONVERTER

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	402543	L

SCALE 2:1 | WT | SHEET 1 OF 1



10. LAST REF DESIGNATORS, ISOLATOR: C28, CR21 Q29, R36
9. LAST REF DESIGNATORS, CONVERTOR: C26, CR11, K3, Q13, R44
8. ALL VOLTAGES ARE APPROXIMATE VALUES MEASURED WITH RESPECT TO ANALOG COMMON
7. ALL CAPACITORS TO BE: 500V, DISC
6. THIS SYMBOL ▽ INDICATES DIGITAL COMMON
5. THIS SYMBOL ▽ INDICATES REFERENCE COMMON
4. THIS SYMBOL ▽ INDICATES ANALOG COMMON
3. ALL DIODES TO BE: 1N8
2. ALL TRANSISTORS TO BE: 2N3565
1. ALL RESISTOR VALUES ARE IN OHMS, 1/4W, ± 5%, CARBON

NOTE: UNLESS OTHERWISE SPECIFIED

⚠12 Q7 AND Q8 ARE SELECTED 2N3565 TRANSISTORS.

12. ARROWS INDICATE SIGNAL FLOW, NOT CURRENT FLOW

⚠1 Q6 IS A SELECTED Q13, P/N 200027.

S1 & S2 — S3 — S4 TOP VIEW

402543	229	REF	REF
NEXT ASSY	USED ON	MA	FA
APPLICATION		QTY REQD	

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON: DECIMALS .X ±.03, .XX ±.02, .XXX ±.010; ANGLES 0° 30'; FORMED ANGLES ±1°
MATERIAL
FINISH

CONTRACT NO.

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC — 220
AC/DC CONVERTER

SIZE	CODE IDENT NO.	DWG NO.	REV
D	21793	430695	N

SCALE NONE WT SHEET 1 OF 2

PARTS LIST

ASSEMBLY 402487 Readout Assembly

REF. DESIG.	PART NO.	DESCRIPTION							
CR01	211083	DIODE SILICO	018			1	DANA	211083	
CR02	211083	DIODE SILICO	018			1	DANA	211083	
CR03	211083	DIODE SILICO	018			1	DANA	211083	
CR04	211083	DIODE SILICO	018			1	DANA	211083	
CR05	402467								
CR06	220004	DIODE SILICO ZENER	1N961B			1	MOTOROLA	1N961B	
CR07	221177	DIODE SILICO ZENER	1/4M2.4AZ5				MOTOROLA	1/4M2.4AZ5	
CR08	211083	DIODE SILICO	018			1	DANA	211083	
CR09	211083	DIODE SILICO	018			1	DANA	211083	
CR10	221177	DIODE SILICO ZENER	1/4M2.4AZ5				MOTOROLA	1/4M2.4AZ5	
CR11	211083	DIODE SILICO	018			1	DANA	211083	
CR12	211083	DIODE SILICO	018			1	DANA	211083	
CR13	211083	DIODE SILICO	018			1	DANA	211083	
CR14	211083	DIODE SILICO	018			1	DANA	211083	
CR15	211083	DIODE SILICO	018			1	DANA	211083	
CR16	211236	DIODE SILICO	007			1	DANA	211236	
CR17	211236	DIODE SILICO	007			1	DANA	211236	
C01	110068	CAP ELEC	5	MFD	25 V		DUCATI	5-25	
C02	120174	CAP POLY	.5	MFD	100 V	5%	CDE	WMF6S1	
C03	110069	CAP ELEC	10	MFD	10 V		KEMET	K10W10K	
C04	110043	CAP ELECT	25	MFD	25 V	20%	DUCATI	25-25	
C05	100006	CAP CERM	22	PFD	500 V	10%	AEROVOX	TCD-N750	
C06	101098	CAP CERAM	330	PFD	500 V	10%1	AEROVOX	SCD1X5F	
C07	101145	CAP CERAM	100	PFD	500 V	10%1	AEROVOX	SCD1X5F	
C08	101145	CAP CERAM	100	PFD	500 V	10%1	AEROVOX	SCD1X5F	
C09	101098	CAP CERAM	330	PFD	500 V	10%1	AEROVOX	SCD1X5F	
C10	110047	CAP ELECT	50	MFD	50 V	20%	DUCATI	50-50	
C11	110071	CAP ELECT	.1	MFD	35 V	10%	KEMET	K1W35K	
C12	100006	CAP CERAM	22	PFD	500 V	10%	AEROVOX	TCD-N750	
C13	101642	CAP CERAM	150	PFD	500 V	10%1	AEROVOX	SCD2X5F	
C14	101174	CAP CERAM	.001	MFD	500 V	10%1	AEROVOX	SCD3X5F	
C15	101174	CAP CERAM	.001	MFD	500 V	10%1	AEROVOX	SCD3X5F	
C16	101174	CAP CERAM	.001	MFD	500 V	10%1	AEROVOX	SCD3X5F	
C17	121091	CAP MYLAR	.033	MFD	100 V	10%1	CDE	WMF1533	
C18	100008	CAP CERAM	82	PFD	500 V	10%	AEROVOX	TCD-N750	
C19	110069	CAP ELEC	10	MFD	10 V		KEMET	K10W10K	
C20	110069	CAP ELEC	10	MFD	10 V		KEMET	K10W10K	
C21	121091	CAP MYLAR	.033	MFD	100 V	10%1	CDE	WMF1533	

PARTS LIST

ASSEMBLY 402487 Readout Assembly

REF. DESIG.	PART NO.	DESCRIPTION						
C22	101182	CAP	CERAM	47 PFD 500 V	10%1		AEROVOX	TCD-N750
C23	101174	CAP	CERAM	.001 MFD 500 V	10%1		AEROVOX	SCD3X5F
C24	101174	CAP	CERAM	.001 MFD 500 V	10%1		AEROVOX	SCD3X5F
C25	101174	CAP	CERAM	.001 MFD 500 V	10%1		AEROVOX	SCD3X5F
C26	101174	CAP	CERAM	.001 MFD 500 V	10%1		AEROVOX	SCD3X5F
C27	101098	CAP	CERAM	330 PFD 500 V	10%1		AEROVOX	SCD1X5F
C28	101182	CAP	CERAM	47 PFD 500 V	10%1		AEROVOX	TCD-N750
DS01	920116	LAMP	NEON	NE-2H			G E	MPG250-3
DS02	920342	NEON		NE-2H			GE	C2A-M
DS03	920116	LAMP	NEON	NE-2H			G E	MPG250-3
M01	230003	INTEGRATED CIRCUIT MC790					MOTOROLA	MC790P
M02	230003	INTEGRATED CIRCUIT MC790					MOTOROLA	MC790P
M03	230003	INTEGRATED CIRCUIT MC790					MOTOROLA	MC790P
M04	230003	INTEGRATED CIRCUIT MC790					MOTOROLA	MC790P
M05	230003	INTEGRATED CIRCUIT MC790					MOTOROLA	MC790P
M06	230003	INTEGRATED CIRCUIT MC790					MOTOROLA	MC790P
M07	230003	INTEGRATED CIRCUIT MC790					MOTOROLA	MC790P
M08	230003	INTEGRATED CIRCUIT MC790					MOTOROLA	MC790P
M09	230003	INTEGRATED CIRCUIT MC790					MOTOROLA	MC790P
M10	230003	INTEGRATED CIRCUIT MC790					MOTOROLA	MC790P
M11	230000	INTEGRATED CIRCUIT MC724					MOTOROLA	MC724P
M12	230000	INTEGRATED CIRCUIT MC724					MOTOROLA	MC724P
M13	230000	INTEGRATED CIRCUIT MC724					MOTOROLA	MC724P
M14	230015	INTEGRATED CIRCUIT MC723P					MOTOROLA	MC723P
M15	230000	INTEGRATED CIRCUIT MC724					MOTOROLA	MC724P
M16	230000	INTEGRATED CIRCUIT MC724					MOTOROLA	MC724P
M17	230000	INTEGRATED CIRCUIT MC724					MOTOROLA	MC724P
M18	230000	INTEGRATED CIRCUIT MC724					MOTOROLA	MC724P
M19	230006	INTEGRATED CIRCUIT MC799P					MOTOROLA	MC799P
M20	230000	INTEGRATED CIRCUIT MC724					MOTOROLA	MC724P
M21	230014	INTEGRATED CIRCUIT UL9960					FAIRCHILD	UL9960
M22	230014	INTEGRATED CIRCUIT UL9960					FAIRCHILD	UL9960
M23	230014	INTEGRATED CIRCUIT UL9960					FAIRCHILD	UL9960
M24	230014	INTEGRATED CIRCUIT UL9960					FAIRCHILD	UL9960
Q01	201084	TRANS GERMAN PNP	2N1304		1		TI	2N1304
Q02	200037	TRANS SILICO NPN	2N3646				FAIRCHILD	2N3646
Q03	200082	TRANS	2N3417				GE	2N3417
Q04	200040	TRANS SILICO NPN	016				DANA	200040

PARTS LIST

ASSEMBLY 402487 Readout Assembly

REF. DESIG.	PART NO.	DESCRIPTION		
Q05	200040	TRANS SILICO NPN	016	DANA 200040
Q06	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q07	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q08	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q09	200052	TRANS SILICO PNP	009	DANA 200052
Q10	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q11	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q12	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q13	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q14	200052	TRANS SILICO PNP	009	DANA 200052
Q15	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q16	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q17	200044	TRANS SILICO NPN DUAL	FSV	DANA 200044
Q18	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q19	200052	TRANS SILICO PNP	009	DANA 200052
Q20	200035	TRANS SILICO NPN	014	DANA 200035
Q21	200022	TRANS SILICO PNP	012	DANA 200022
Q22	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q23	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q24	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q25	200035	TRANS SILICO NPN	014	DANA 200035
Q26	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q27	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q28	200040	TRANS SILICO NPN	016	DANA 200040
Q29	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q30	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q31	200022	TRANS SILICO PNP	012	DANA 200022
Q32	200043	TRANS SILICO NPN	2N3565	FAIRCHILD 2N3565
Q33	200035	TRANS SILICO NPN	014	DANA 200035
Q34	200037	TRANS SILICO NPN	2N3646	FAIRCHILD 2N3646
Q35	200075	TRANS	2N4870	MOTOROLA 2N4870
Q36	200035	TRANS SILICO NPN	014	DANA 200035
Q37	200035	TRANS SILICO NPN	014	DANA 200035
Q38	200037	TRANS SILICO NPN	2N3646	FAIRCHILD 2N3646
Q39	200035	TRANS SILICO NPN	014	DANA 200035
Q40	200035	TRANS SILICO NPN	014	DANA 200035
Q41	200035	TRANS SILICO NPN	014	DANA 200035
Q42	200079	TRANS	021	DANA 200079

PARTS LIST

ASSEMBLY 402487 Readout Assembly

A

REF. DESIG.	PART NO.	DESCRIPTION							
Q43	200035	TRANS SILICO NPN			014			DANA	200035
Q44	200037	TRANS SILICO NPN			2N3646			FAIRCHILD	2N3646
Q45	200035	TRANS SILICO NPN			014			DANA	200035
Q46	200035	TRANS SILICO NPN			014			DANA	200035
Q47	200035	TRANS SILICO NPN			014			DANA	200035
Q48	200035	TRANS SILICO NPN			014			DANA	200035
R01	040101	RES	VARI	50 OHM				CTS	
R02	040086	RES	VARI	2 K	10%			BECKMAN	62PR2K
R03	020241	RES	WW	10 K	.05%	1/8 W		JORDAN	J-11
R04	020391	RES	WW	11.4 K	.5%	1/8 W		JORDAN	J11
R05	020241	RES	WW	10 K	.05%	1/8 W		JORDAN	J-11
R06	000183	RES	CARBON	18 K	5%	1/4 W1		OHMITE	RC07GF183J
R07	000202	RES	CARBON	2 K	5%	1/4 W1		OHMITE	RC07GF202J
R10	000102	RES	CARBON	1 K	5%	1/4 W1		OHMITE	RC07GF102J
R11	040087	RES	VARI	10 K	10%	1/4 W		BECKMAN	62PR10K
R12	000202	RES	CARBON	2 K	5%	1/4 W1		OHMITE	RC07GF202J
R13	000333	RES	CARBON	33 K	5%	1/4 W		OHMITE	RC07GF333J
R14	010149	RES	METAL	499 OHM	1%	1/4 W		ELECTRA	RN60D4990F
R15	040098	RES	VARI	20 K	10%			BECKMAN	62PR20K
R16	402467								
R17	000103	RES	CARBON	10 K	5%	1/4 W1		OHMITE	RC07GF103J
R18	020390	RES	WW	1 K	.05%	1/8 W		JORDAN	J11
R19	010038	RES	METAL	422 K	1%	1/4 W		ELECTRA	RN60D4223F
R20	040088	RES	VARI	100 K	10%			BECKMAN	62PR100K
R21	010038	RES	METAL	422 K	1%	1/4 W		ELECTRA	RN60D4223F
R22	000184	RES	CARBON	180 K	5%	1/4 W		OHMITE	RC07GF184J
R23	000184	RES	CARBON	180 K	5%	1/4 W		OHMITE	RC07GF184J
R24	010038	RES	METAL	422 K	1%	1/4 W		ELECTRA	RN60D4223F
R25	040088	RES	VARI	100 K	10%			BECKMAN	62PR100K
R26	010038	RES	METAL	422 K	1%	1/4 W		ELECTRA	RN60D4223F
R27	000363	RES	CARBON	36 K	5%	1/4 W1		OHMITE	RC07GF363J
R28	000183	RES	CARBON	18 K	5%	1/4 W1		OHMITE	RC07GF183J
R29	402467								
R30	010063	RES	METAL	3.92 K	1%	1/4 W		ELECTRA	RN60D3921F
R31	000681	RES	CARBON	680 OHM	5%	1/4 W1		OHMITE	RC07GF681J
R32	000512	RES	CARBON	5.1 K	5%	1/4 W1		OHMITE	RC07GF512J
R33	000512	RES	CARBON	5.1 K	5%	1/4 W1		OHMITE	RC07GF512J

PARTS LIST

ASSEMBLY 402487 Readout Assembly

A

REF. DESIG.	PART NO.	DESCRIPTION							
R34	001737	RES	FSV		5%	1/4 W	DANA	001737	
R35	020468	RES	WW	6 K	.5%		JORDAN	J11	
R36	040086	RES	VARI	2 K	10%		BECKMAN	62PR2K	
R37	020389	RES	WW	5 K	.5%	1/8 W	JORDAN	J11	
R38	000332	RES	CARBON	3.3 K	5%	1/4 W1	OHMITE	RC07GF332J	
R39	000223	RES	CARBON	22 K	5%	1/4 W	OHMITE	RC07GF223J	
R40	000393	RES	CARBON	39 K	5%	1/4 W	OHMITE	RC07GF393J	
R41	000244	RES	CARBON	240 K	5%	1/4 W1	OHMITE	RC07GF244J	
R42	000272	RES	CARBON	2.7 K	5%	1/4 W	OHMITE	RC07GF272J	
R43	000163	RES	CARBON	16 K	5%	1/4 W1	OHMITE	RC07GF163J	
R44	000203	RES	CARBON	20 K	5%	1/4 W1	OHMITE	RC07GF203J	
R45	000910	RES	CARBON	91 OHM	5%	1/4 W1	OHMITE	RC07GF910J	
R46	000910	RES	CARBON	91 OHM	5%	1/4 W1	OHMITE	RC07GF910J	
R47	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J	
R48	000154	RES	CARBON	150 K	5%	1/4 W1	OHMITE	RC07GF154J	
R49	000821	RES	CARBON	820 OHM	5%	1/4 W	OHMITE	RC07GF821J	
R50	000391	RES	CARBON	390 OHM	5%	1/4 W	OHMITE	RC07GF391J	
R51	000332	RES	CARBON	3.3K	5%	1/4 W	OHMITE	RC07GF332J	
R52	000472	RES	CARBON	4.7K	5%	1/4 W1	OHMITE	RC07GF472J	
R53	000391	RES	CARBON	390 OHM	5%	1/4 W	OHMITE	RC07GF391J	
R54	000393	RES	CARBON	39 K	5%	1/4 W	OHMITE	RC07GF393J	
R55	040053	RES	VARI	5 K	10%	1.5 W	CTS	110	
R56	010137	RES	METAL	100 OHM	1%	1/4 W	ELECTRA	RN60D1000F	
R57	020406	RES	WW	4.893 K	.05%	1/8 W	JORDAN	J11	
R58	020241	RES	WW	10 K	.05%	1/8 W	JORDAN	J-11	
R59	020241	RES	WW	10 K	.05%	1/8 W	JORDAN	J-11	
R60	000200	RES	CARBON	20 OHM	5%	1/4 W	OHMITE	RC07GF200J	
R61	000201	RES	CARBON	200 OHM	5%	1/4 W1	OHMITE	RC07GF201J	
R62	000103	RES	CARBON	10 K	5%	1/4 W1	OHMITE	RC07GF103J	
R63	040087	RES	VARI	10 K	10%	1/4 W	BECKMAN	62PR10K	
R64	000104	RES	CARBON	100 K	5%	1/4 W1	OHMITE	RC07GF104J	
R65	000152	RES	CARBON	1.5 K	5%	1/4 W1	OHMITE	RC07GF152J	
R66	000152	RES	CARBON	1.5 K	5%	1/4 W1	OHMITE	RC07GF152J	
R67	000472	RES	CARBON	4.7 K	5%	1/4 W1	OHMITE	RC07GF472J	
R68	010013	RES	METAL	60.4 K	1%	1/4 W	ELECTRA	RN60C6042F	
R69	010059	RES	METAL	20 K	1%	1/4 W	ELECTRA	RN60D2002F	
R70	040097	RES	VARI	5 K	10%		BECKMAN	62PR5K	
R71	010059	RES	METAL	20 K	1%	1/4 W	ELECTRA	RN60D2002F	
R72	010078	RES	METAL	86.6 K	1%	1/4 W	ELECTRA	RN60B8662F	

PARTS LIST

ASSEMBLY 402487 Readout Assembly

A

REF. DESIG.	PART NO.	DESCRIPTION						
R73	000563	RES	CARBON	56 K	5%	1/4 W	OHMITE	RC07GF563J
R74	000104	RES	CARBON	100 K	5%	1/4 W1	OHMITE	RC07GF104J
R75	000183	RES	CARBON	18 K	5%	1/4 W1	OHMITE	RC07GF183J
R76	000202	RES	CARBON	2 K	5%	1/4 W1	OHMITE	RC07GF202J
R77	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R78	000512	RES	CARBON	5.1 K	5%	1/4 W1	OHMITE	RC07GF512J
R79	000302	RES	CARBON	3 K	5%	1/4 W1	OHMITE	RC07GF302J
R80	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R81	000221	RES	CARBON	220 OHM	5%	1/4 W1	OHMITE	RC07GF221J
R82	000273	RES	CARBON	27 K	5%	1/4 W1	OHMITE	RC07GF273J
R83	000103	RES	CARBON	10 K	5%	1/4 W1	OHMITE	RC07GF103J
R84	000223	RES	CARBON	22 K	5%	1/4 W	OHMITE	RC07GF223J
R85	000511	RES	CARBON	510 OHM	5%	1/4 W1	OHMITE	RC07GF511J
R86	000101	RES	CARBON	100 OHM	5%	1/4 W1	OHMITE	RC07GF101J
R87	001745	RES	CARBON	56 K	5%	1/2 W	OHMITE	RC20GF563J
R88	001744	RES	CARBON	27 K	5%	1/2 W	OHMITE	RC20GF273J
R89	000302	RES	CARBON	3 K	5%	1/4 W1	OHMITE	RC07GF302J
R90	000302	RES	CARBON	3 K	5%	1/4 W1	OHMITE	RC07GF302J
R91	000202	RES	CARBON	2 K	5%	1/4 W1	OHMITE	RC07GF202J
R92	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R93	001744	RES	CARBON	27 K	5%	1/2 W	OHMITE	RC20GF273J
R94	001745	RES	CARBON	56 K	5%	1/2 W	OHMITE	RC20GF563J
R95	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R96	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R97	000623	RES	CARBON	62 K	5%	1/4 W1	OHMITE	RC07GF623J
R98	000302	RES	CARBON	3 K	5%	1/4 W1	OHMITE	RC07GF302J
R99	000223	RES	CARBON	22 K	5%	1/4 W	OHMITE	RC07GF223J
R100	001744	RES	CARBON	27 K	5%	1/2 W	OHMITE	RC20GF273J
R101	001745	RES	CARBON	56 K	5%	1/2 W	OHMITE	RC20GF563J
R102	000471	RES	CARBON	470 OHM	5%	1/4 W1	OHMITE	RC07GF471J
R103	000302	RES	CARBON	3 K	5%	1/4 W1	OHMITE	RC07GF302J
R104	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R105	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R106	001744	RES	CARBON	27 K	5%	1/2 W	OHMITE	RC20GF273J
R107	001745	RES	CARBON	56 K	5%	1/2 W	OHMITE	RC20GF563J
R108	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R109	000623	RES	CARBON	62 K	5%	1/4 W1	OHMITE	RC07GF623J

PARTS LIST

ASSEMBLY 402487 Readout Assembly

A

REF. DESIG.	PART NO.	DESCRIPTION						
R110	000302	RES	CARBON	3 K	5%	1/4 W1	OHMITE	RC07GF302J
R111	001745	RES	CARBON	56 K	5%	1/2 W	OHMITE	RC20GF563J
R112	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R113	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R114	001744	RES	CARBON	27 K	5%	1/2 W	OHMITE	RC20GF273J
R115	000100	RES	CARBON	10 OHM	5%	1/4 W1	OHMITE	RC07GF100J
R116	000202	RES	CARBON	2 K	5%	1/4 W1	OHMITE	RC07GF202J

PARTS LIST

ASSEMBLY 402498 PCB Assembly- Power Supply 4470 A

REF. DESIG.	PART NO.	DESCRIPTION						
CR01	210004	DIODE SILICO	SD4				DIODES IN SD4	
CR02	210004	DIODE SILICO	SD4				DIODES IN SD4	
CR03	210004	DIODE SILICO	SD4				DIODES IN SD4	
CR04	210004	DIODE SILICO	SD4				DIODES IN SD4	
CR05	210004	DIODE SILICO	SD4				DIODES IN SD4	
CR06	210004	DIODE SILICO	SD4				DIODES IN SD4	
CR07	210014	DIODE SILICO	023				DANA	210014
CR08	210014	DIODE SILICO	023				DANA	210014
CR09	210014	DIODE SILICO	023				DANA	210014
CR10	210014	DIODE SILICO	023				DANA	210014
CR11	221177	DIODE SILICO ZENER			1/4 W1		MOTOROLA	M.2.4A25
CR12	220015	DIODE SILICO ZENER 1N967B					MOTOROLA	1N967B
CR13	220015	DIODE SILICO ZENER 1N967B					MOTOROLA	1N967B
C01	121088	CAP MYLAR	.01 MFD	100 V	10%		CDE	WMF1S1
C02	110067	CAP ELECT	2000 MFD	35 V	20%		DUCATI	2000-35
C03	110067	CAP ELECT	2000 MFD	35 V	20%		DUCATI	2000-35
C04	121088	CAP MYLAR	.01 MFD	100 V	10%		CDE	WMF1S1
C05	110085	CAP ELECT	2000 MFD	10 V	20%		DUCATI	2000-10
C06	110083	CAP ELECT	100 MFD	10 V	20%		DUCATI	100-10
C07	120072	CAP MYLAR	.01 MFD	600 V	10%		CDE	WMF651
C08	110065	CAP ELECT	20 MFD	350 V	20%		DUCATI	20-350
C09	110066	CAP ELECT	15 MFD	200 V	20%		DUCATI	15-200
C10	110083	CAP ELECT	100 MFD	10 V	20%		DUCATI	100-10
C11	121088	CAP MYLAR	.01 MFD	100 V	10%		CDE	WMF1S1
C12	110043	CAP ELECT	25 MFD	25 V	20%		DUCATI	25-25
C13	110043	CAP ELECT	25 MFD	25 V	20%		DUCATI	25-25
C14	101174	CAP CERAM	.001 MFD	500 V	10%1		AEROVOX	SCD3X5F
C15	101174	CAP CERAM	.001 MFD	500 V	10%1		AEROVOX	SCD3X5F
C16	110077	CAP ELECT	1000 UF	15/16 V	20%		CDE	BR1000-15
Q01	200043	TRANS SILICO NPN	2N3565				FAIRCHILD	2N3565
Q02	200035	TRANS SILICO NPN	014				DANA	200035
Q03	200030	TRANS SILICO NPN	40250				RCA	40250
Q04	200035	TRANS SILICO NPN	014				DANA	200035
Q05	200011	TRANS SILICO PNP	009				DANA	200011
R01	000241	RES CARBON	240 OHM		5%	1/4 W1	OHMITE	RC07GF241J
R02	000241	RES CARBON	240 OHM		5%	1/4 W1	OHMITE	RC07GF241J
R03	030014	RES CARBON	220-K		5%	1 W	OHMITE	RC32GF224J
R04	000751	RES CARBON	750 OHM		5%	1/4 W1	OHMITE	RC07GF751J

PARTS LIST

ASSEMBLY 402498 PCB Assembly - Power Supply 4470

A

REF. DESIG.	PART NO.	DESCRIPTION							
R05	000751	RES	CARBON	750	OHM	5%	1/4 W1	OHMITE	RC07GF751J
R06	000224	RES	CARBON	220	K	5%	1/4 W1	OHMITE	RC07GF224J
R07	000202	RES	CARBON	2	K	5%	1/4 W1	OHMITE	RC07GF202J
R08	030007	RES	CARBON	150	OHM	5%	3 W	OHMITE	4396
R09	000151	RES	CARBON	150	OHM	5%	1/4 W1	OHMITE	RC07GF151J
R10	000151	RES	CARBON	150	OHM	5%	1/4 W1	OHMITE	RC07GF151J
R11	000202	RES	CARBON	2	K	5%	1/4 W1	OHMITE	RC07GF202J
R12	030007	RES	CARBON	150	OHM	5%	3 W	OHMITE	4396
R13	040063	RES	VARI	500	OHM	10%	1.5 W	CTS	110
R14	000511	RES	CARBON	510	OHM	5%	1/4 W1	OHMITE	RC07GF511J

PARTS LIST

ASSEMBLY 402489 PCB Assembly - Power Supply, 4430 A

REF. DESIG.	PART NO.	DESCRIPTION
CR01	210004	DIODE SILICO SD4 DIODES IN SD4
CR02	210004	DIODE SILICO SD4 DIODES IN SD4
CR03	210004	DIODE SILICO SD4 DIODES IN SD4
CR04	210004	DIODE SILICO SD4 DIODES IN SD4
CR05	210004	DIODE SILICO SD4 DIODES IN SD4
CR06	210004	DIODE SILICO SD4 DIODES IN SD4
CR07	210014	DIODE SILICO 023 DANA 210014
CR08	210014	DIODE SILICO 023 DANA 210014
CR09	210014	DIODE SILICO 023 DANA 210014
CR10	210014	DIODE SILICO 023 DANA 210014
CR11	221177	DIODE SILICO ZENER 1/4 W1 MOTOROLA M.2.4A25
CR12	220015	DIODE SILICO ZENER 1N967B MOTOROLA 1N967B
CR13	220015	DIODE SILICO ZENER 1N967B MOTOROLA 1N967B
C01	121088	CAP MYLAR .01 MFD 100 V 10% CDE WMF1S1
C02	110067	CAP ELECT 2000 MFD 35 V 20% DUCATI 2000-35
C03	110067	CAP ELECT 2000 MFD 35 V 20% DUCATI 2000-35
C04	121088	CAP MYLAR .01 MFD 100 V 10% CDE WMF1S1
C05	110085	CAP ELECT 2000 MFD 10 V 20% DUCATI 2000-10
C06	110083	CAP ELECT 100 MFD 10 V 20% DUCATI 100-10
C07	120072	CAP MYLAR .01 MFD 600 V 10% CDE WMF651
C08	110065	CAP ELECT 20 MFD 350 V 20% DUCATI 20-350
C09	110066	CAP ELECT 15 MFD 200 V 20% DUCATI 15-200
C10	110083	CAP ELECT 100 MFD 10 V 20% DUCATI 100-10
C11	121088	CAP MYLAR .01 MFD 100 V 10% CDE WMF1S1
C12	110043	CAP ELECT 25 MFD 25 V 20% DUCATI 25-25
C13	110043	CAP ELECT 25 MFD 25 V 20% DUCATI 25-25
C14	101174	CAP CERAM .001 MFD 500 V 10%1 AEROVOX SCD3X5F
C15	101174	CAP CERAM .001 MFD 500 V 10%1 AEROVOX SCD3X5F
C16	110077	CAP ELECT 1000 UF 15/16 V 20% CDE BR1000-15
Q01	200043	TRANS SILICO NPN 2N3565 FAIRCHILD 2N3565
Q02	200035	TRANS SILICO NPN 014 DANA 200035
Q03	200030	TRANS SILICO NPN 40250 RCA 40250
Q04	200035	TRANS SILICO NPN 014 DANA 200035
Q05	200011	TRANS SILICO PNP 009 DANA 200011
R01	000241	RES CARBON 240 OHM 5% 1/4 W1 OHMITE RC07GF241J
R02	000241	RES CARBON 240 OHM 5% 1/4 W1 OHMITE RC07GF241J
R03	030014	RES CARBON 220 K 5% 1 W OHMITE RC32GF224J
R04	000751	RES CARBON 750 OHM 5% 1/4 W1 OHMITE RC07GF751J

PARTS LIST

ASSEMBLY 402489 PCB Assembly - Power Supply, 4430 A

REF. DESIG.	PART NO.	DESCRIPTION							
R05	000751	RES	CARBON	750	OHM	5%	1/4 W1	OHMITE	RC07GF751J
R06	000224	RES	CARBON	220	K	5%	1/4 W1	OHMITE	RC07GF224J
R07	000202	RES	CARBON	2	K	5%	1/4 W1	OHMITE	RC07GF202J
R08	030007	RES	CARBON	150	OHM	5%	3 W	OHMITE	4396
R09	000151	RES	CARBON	150	OHM	5%	1/4 W1	OHMITE	RC07GF151J
R10	000151	RES	CARBON	150	OHM	5%	1/4 W1	OHMITE	RC07GF151J
R11	000202	RES	CARBON	2	K	5%	1/4 W1	OHMITE	RC07GF202J
R12	030007	RES	CARBON	150	OHM	5%	3 W	OHMITE	4396
R13	040063	RES	VARI	500	OHM	10%	1.5 W	CTS	110
R14	000511	RES	CARBON	510	OHM	5%	1/4 W1	OHMITE	RC07GF511J

PARTS LIST

ASSEMBLY 402493 PCB Assembly - DC Auto, 210 A

REF. DESIG.	PART NO.	DESCRIPTION							
CR01	211083	DIODE SILICO	018			1	DANA	211083	
CR02	220016	DIODE SILICO ZENER	1N964B				MOTOROLA	1N964B	
CR03	220016	DIODE SILICO ZENER	1N964B				MOTOROLA	1N964B	
CR04	211236	DIODE SILICO	007				DANA	211236	
CR05	211236	DIODE SILICO	007				DANA	211236	
CR06	220004	DIODE SILICO ZENER	1N961B			1	MOTOROLA	1N961B	
CR07	211236	DIODE SILICO	007				DANA	211236	
CR08	211236	DIODE SILICO	007				DANA	211236	
CR09	211083	DIODE SILICO	018			1	DANA	211083	
CR10	211083	DIODE SILICO	018			1	DANA	211083	
CR11	211083	DIODE SILICO	018			1	DANA	211083	
CR12	211083	DIODE SILICO	018			1	DANA	211083	
CR14	211083	DIODE SILICO	018			1	DANA	211083	
CR15	211083	DIODE SILICO	018			1	DANA	211083	
CR16	211083	DIODE SILICO	018			1	DANA	211083	
CR17	220022	DIODE SILICO ZENER	1N965B				MOTOROLA	1N965B	
CR18	220022	DIODE SILICO ZENER	1N965B				MOTOROLA	1N965B	
CR19	211083	DIODE SILICO	018			1	DANA	211083	
CR20	220004	DIODE SILICO ZENER	1N961B			1	MOTOROLA	1N961B	
CR21	220004	DIODE SILICO ZENER	1N961B			1	MOTOROLA	1N961B	
C01	110070	CAP ELECT	22 MFD	6 V	10%	KEMET	K22W6K		
C02	120177	CAP MYLAR	.56 MFD	50 V	5%	IMB	PV2A564J		
C04	110086	CAP TANTA	47 MFD	10 V	10%	KEMET	K47C6K		
C05	101182	CAP CERAM	47 PFD	500 V	10%1	AEROVOX	TCD-N750		
C06	110043	CAP ELECT	25 MFD	25 V	20%	DUCATI	25-25		
C07	120178	CAP MYLAR	.27 MFD	50 V	5%	IMB	PV2A274J		
C08	120011	CAP POLYS	.068 MFD	100 V	10%	CDE	WMF1568		
C09	120135	CAP POLYS	.015 MFD	33 V	10%	MIAL	611.3S		
C10	120137	CAP MYLAR	.56 MFD	200 V	10%	IMB	XA2C56K		
C11	120153	CAP POLYS	47 PFD	125 V	10%	MIAL	611		
C12	101145	CAP CERAM	100 PFD	500 V	10%1	AEROVOX	SCD1X5F		
C13	101145	CAP CERAM	100 PFD	500 V	10%1	AEROVOX	SCD1X5F		
C14	110071	CAP ELECT	.1 MFD	35 V	10%	KEMET	K1W35K		
C15	110047	CAP ELECT	50 MFD	50 V	20%	DUCATI	50-50		
C16	110047	CAP ELECT	50 MFD	50 V	20%	DUCATI	50-50		
C17	121468	CAP MYLAR	.022 MFD	100 V	10%1	CDE	WMF1S22		
C18	101099	CAP CERAM	680 PFD	500 V	10%1	AEROVOX	SCD2X5F		

PARTS LIST

ASSEMBLY 402493 PCB Assembly - DC Auto, 210 A

REF. DESIG.	PART NO.	DESCRIPTION							
C19	110071	CAP	ELECT	.1 MFD	35 V	10%		KEMET	K1W35K
C20	120134	CAP	MYLAR	1 MFD	200 V	10%		PAKTRON	MF1200LL
C24	101175	CAP	CERAM	220 PFD	500 V	10%1		AEROVOX	SCD1X5F
C25	101175	CAP	CERAM	220 PFD	500 V	10%1		AEROVOX	SCD1X5F
K01	310029	RELAY						AM ZETTLR	AZ420-56
K02	310021	RELAY DC		2 PDT	24V		1	ALLIED	AZ42056105
M01	230000	INTEGRATED CIRCUIT MC724						MOTOROLA	MC724P
M02	230000	INTEGRATED CIRCUIT MC724						MOTOROLA	MC724P
M03	230003	INTEGRATED CIRCUIT MC790						MOTOROLA	MC790P
M04	230000	INTEGRATED CIRCUIT MC724						MOTOROLA	MC724P
Q01	200035	TRANS SILICO NPN		014				DANA	200035
Q02	200043	TRANS SILICO NPN		2N3565				FAIRCHILD	2N3565
Q03	200043	TRANS SILICO NPN		2N3565				FAIRCHILD	2N3565
Q04	200043	TRANS SILICO NPN		2N3565				FAIRCHILD	2N3565
Q05	200043	TRANS SILICO NPN		2N3565				FAIRCHILD	2N3565
Q06	200036	TRANS SILICO NPN		015				DANA	200036
Q07	200037	TRANS SILICO NPN		2N3646				FAIRCHILD	2N3646
Q08	200040	TRANS SILICO NPN		016				DANA	200040
Q09	200040	TRANS SILICO NPN		016				DANA	200040
Q10	200068	TRANS		2N4250				FAIRCHILD	2N4250
Q11	200043	TRANS SILICO NPN		2N3565				FAIRCHILD	2N3565
Q12	200011	TRANS SILICO PNP		009				DANA	200011
Q13	201084	TRANS GERMAN PNP		2N1304			1	TI	2N1304
Q14	200043	TRANS SILICO NPN		2N3565				FAIRCHILD	2N3565
Q15	200035	TRANS SILICO NPN		014				DANA	200035
Q16	200022	TRANS SILICO PNP		012				DANA	200022
Q17	200043	TRANS SILICO NPN		2N3565				FAIRCHILD	2N3565
Q18	200022	TRANS SILICO PNP		012				DANA	200022
Q19	200043	TRANS SILICO NPN		2N3565				FAIRCHILD	2N3565
Q20	200035	TRANS SILICO NPN		014				DANA	200035
R01	000102	RES	CARBON	1 K		5%	1/4 W1	OHMITE	RC07GF102J
R02	030015	RES	WW	100K		1%	10 W	C-F	M-100
R03	010334	RES		SET				DANA	010334
R04	040062	RES	VARI	500 OHM		10%	1.5 W	CTS	110
R05	010334	RES		SET				DANA	010334
R06	000513	RES	CARBON	51 K		5%	1/4 W1	OHMITE	RC07GF513J
R07	000514	RES	CARBON	510 K		5%	1/4 W1	OHMITE	RC07GF524J
R08	000513	RES	CARBON	51 K		5%	1/4 W1	OHMITE	RC07GF513J
R09	000205	RES	CARBON	2 M		5%	1/4 W1	OHMITE	RC07GF205J
R10	000202	RES	CARBON	2 K		5%	1/4 W1	OHMITE	RC07GF202J

PARTS LIST

ASSEMBLY 402493 PCB Assembly - DC Auto, 210 A

REF. DESIG.	PART NO.	DESCRIPTION						
R11	000154	RES	CARBON	150 K	5%	1/4 W1	OHMITE	RC07GF154J
R12	000912	RES	CARBON	9.1 K	5%	1/4 W1	OHMITE	RC07GF912J
R13	000103	RES	CARBON	10 K	5%	1/4 W1	OHMITE	RC07GF103J
R14	010059	RES	METAL	20 K	1%	1/4 W	ELECTRA	RN60D2002F
R15	000513	RES	CARBON	51 K	5%	1/4 W1	OHMITE	RC07GF513J
R16	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R17	000244	RES	CARBON	240 K	5%	1/4 W1	OHMITE	RC07GF244J
R18	010337	RES	METAL	10 MEG	1%		DALE	DCS1/2
R19	040099	RES	VARI	1 MEG	10%	1/4 W	BECKMAN	62PRIM
R20	000755	RES	CARBON	7.5 M	5%	1/4 W	OHMITE	RC07GF755J
R22	040100	RES	VARI	500 K			CTS	137.6818
R23	010337	RES	METAL	10 MEG	1%		DALE	DCS1/2
R24	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R25	000516	RES	CARBON	51 M	5%	1/4 W	OHMITE	RC07GF516J
R26	000184	RES	CARBON	180 K	5%	1/4 W	OHMITE	RC07GF184J
R27	000104	RES	CARBON	100 K	5%	1/4 W1	OHMITE	RC07GF104J
R28	000101	RES	CARBON	100 OHM	5%	1/4 W1	OHMITE	RC07GF101J
R29	000123	RES	CARBON	12 K	5%	1/4 W1	OHMITE	RC07GF123J
R30	000513	RES	CARBON	51 K	5%	1/4 W1	OHMITE	RC07GF513J
R31	040087	RES	VARI	10 K	10%	1/4 W	BECKMAN	62PR10K
R32	000432	RES	CARBON	4.3 K	5%	1/4 W1	OHMITE	RC07GF432J
R33	000301	RES	CARBON	300 OHM	5%	1/4 W	OHMITE	RC07GF301J
R34	000512	RES	CARBON	5.1 K	5%	1/4 W1	OHMITE	RC07GF512J
R35	000271	RES	CARBON	270 OHM	5%	1/4 W	OHMITE	RC07GF271J
R36	000202	RES	CARBON	2 K	5%	1/4 W1	OHMITE	RC07GF202J
R37	000513	RES	CARBON	51 K	5%	1/4 W1	OHMITE	RC07GF513J
R38	000912	RES	CARBON	9.1 K	5%	1/4 W1	OHMITE	RC07GF912J
R39	000153	RES	CARBON	15 K	5%	1/4 W1	OHMITE	RC07GF153J
R40	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R41	000432	RES	CARBON	4.3 K	5%	1/4 W1	OHMITE	RC07GF432J
R42	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R43	000820	RES	CARBON	82 OHM	5%	1/4 W	OHMITE	RC07GF820J
R44	000820	RES	CARBON	82 OHM	5%	1/4 W	OHMITE	RC07GF820J
R45	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R46	000101	RES	CARBON	100 OHM	5%	1/4 W1	OHMITE	RC07GF101J
R47	000103	RES	CARBON	10 K	5%	1/4 W1	OHMITE	RC07GF103J
R48	020241	RES	WW	10 K	.05%	1/8 W	JORDAN	J-11
R49	020204	RES	WW	1.1111 K	.05%	1/8 W	JORDAN	J-11

PARTS LIST

ASSEMBLY 402493 PCB Assembly - DC Auto, 210

A

REF. DESIG.	PART NO.	DESCRIPTION						
R50	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R51	000514	RES	CARBON	510 K	5%	1/4 W1	OHMITE	RC07GF524J
R52	000153	RES	CARBON	15 K	5%	1/4 W1	OHMITE	RC07GF153J
R53	040053	RES	VARI	5 K	10%	1.5 W	CTS	110
R54	001734	RES	FSV				DANA	001734
R55	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R56	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R57	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R58	-000511	RES	CARBON	510 OHM	5%	1/4 W1	OHMITE	RC07GF511J
R59	000151	RES	CARBON	150 OHM	5%	1/4 W	OHMITE	RG07GF151J

PARTS LIST

ASSEMBLY 402515 Isolator AC/DC Assembly, 220 A

REF. DESIG.	PART NO.	DESCRIPTION							
CR01	211083	DIODE SILICO		018		1	DANA	211083	
CR02	220016	DIODE SILICO	ZENER	1N964B			MOTOROLA	1N964B	
CR03	220016	DIODE SILICO	ZENER	1N964B			MOTOROLA	1N964B	
CR04	211236	DIODE SILICO		007			DANA	211236	
CR05	220004	DIODE SILICO	ZENER	1N961B		1	MOTOROLA	1N961B	
CR06	211236	DIODE SILICO		007			DANA	211236	
CR07	211236	DIODE SILICO		007			DANA	211236	
CR08	211236	DIODE SILICO		007			DANA	211236	
CR09	211083	DIODE SILICO		018		1	DANA	211083	
CR10	211083	DIODE SILICO		018		1	DANA	211083	
CR11	211083	DIODE SILICO		018		1	DANA	211083	
CR12	211083	DIODE SILICO		018		1	DANA	211083	
CR14	211083	DIODE SILICO		018		1	DANA	211083	
CR15	211083	DIODE SILICO		018		1	DANA	211083	
CR16	211083	DIODE SILICO		018		1	DANA	211083	
CR17	220022	DIODE SILICO	ZENER	1N965B			MOTOROLA	1N965B	
CR18	220022	DIODE SILICO	ZENER	1N965B			MOTOROLA	1N965B	
CR19	211083	DIODE SILICO		018		1	DANA	211083	
CR20	220004	DIODE SILICO	ZENER	1N961B		1	MOTOROLA	1N961B	
CR21	220004	DIODE SILICO	ZENER	1N961B		1	MOTOROLA	1N961B	
CR22	211083	DIODE SILICO		018		1	DANA	211083	
CR23	211083	DIODE SILICO		018		1	DANA	211083	
CR24	211083	DIODE SILICO		018		1	DANA	211083	
CR25	211083	DIODE SILICO		018		1	DANA	211083	
C01	110086	CAP	TANTA	47 MFD	10 V	10%	KEMET	K47C6K	
C03	120177	CAP	MYLAR	.56 MFD	50 V	5%	IMB	PV2A564J	
C04	101182	CAP	CERAM	47 PFD	500 V	10%1	AEROVOX	TCD-N750	
C05	110043	CAP	ELECT	25 MFD	25 V	20%	DUCATI	25-25	
C06	120178	CAP	MYLAR	.27 MFD	50 V	5%	IMB	PV2A274J	
C07	120011	CAP	POLYS	.068 MFD	100 V	10%	CDE	WMF1568	
C08	120135	CAP	POLYS	.015 MFD	33 V	10%	MIAL	611.3S	
C09	120137	CAP	MYLAR	.56 MFD	200 V	10%	IMB	XA2C56K	
C10	120153	CAP	POLYS	47 PFD	125 V	10%	MIAL	611	
C11	101145	CAP	CERAM	100 PFD	500 V	10%1	AEROVOX	SCD1X5F	
C12	101145	CAP	CERAM	100 PFD	500 V	10%1	AEROVOX	SCD1X5F	
C13	110071	CAP	ELECT	.1 MFD	35 V	10%	KEMET	K1W35K	
C14	110047	CAP	ELECT	50 MFD	50 V	20%	DUCATI	50-50	

PARTS LIST

ASSEMBLY 402515 Isolator AC/DC Assembly, 220

REF. DESIG.	PART NO.	DESCRIPTION						
C15	110047	CAP	ELECT	50 MFD	50 V	20%	DUCATI	50-50
C16	121468	CAP	MYLAR	.022 MFD	100 V	10%1	CDE	WMF1S22
C17	101099	CAP	CERAM	680 PFD	500 V	10%1	AEROVOX	SCD2X5F
C18	110071	CAP	ELECT	.1 MFD	35 V	10%	KEMET	K1W35K
C19	120134	CAP	MYLAR	1 MFD	200 V	10%	PAKTRON	MF1200LL
C20	110070	CAP	ELECT	22 MFD	6 V	10%	KEMET	K22W6K
C22	120184	CAP	POLYS	.001 MFD	1000V	5%	MIAL	611
C24	101175	CAP	CERAM	220 PFD	500V	10%1	AEROVOX	SCD1X5F
C25	101175	CAP	CERAM	220 PFD	500V	10%1	AEROVOX	SCD1X5F
K01	310029	RELAY					AM ZETTLR	AZ420-56
K02	310021	RELAY DC		2 PDT	24V	1	ALLIED	AZ42056105
M01	230000	INTEGRATED CIRCUIT MC724					MOTOROLA	MC724P
M02	230000	INTEGRATED CIRCUIT MC724					MOTOROLA	MC724P
M03	230003	INTEGRATED CIRCUIT MC790					MOTOROLA	MC790P
M04	230000	INTEGRATED CIRCUIT MC724					MOTOROLA	MC724P
Q01	200035	TRANS SILICO NPN		014			DANA	200035
Q02	200043	TRANS SILICO NPN		2N3565			FAIRCHILD	2N3565
Q03	200043	TRANS SILICO NPN		2N3565			FAIRCHILD	2N3565
Q04	200043	TRANS SILICO NPN		2N3565			FAIRCHILD	2N3565
Q05	200043	TRANS SILICO NPN		2N3565			FAIRCHILD	2N3565
Q06	200027	TRANS SILICO		FSV			DANA	200027
Q07	200037	TRANS SILICO NPN		2N3646			FAIRCHILD	2N3646
Q08	200040	TRANS SILICO NPN		016			DANA	200040
Q09	200040	TRANS SILICO NPN		016			DANA	200040
Q10	200068	TRANS		2N4250			FAIRCHILD	2N4250
Q11	200043	TRANS SILICO NPN		2N3565			FAIRCHILD	2N3565
Q12	200011	TRANS SILICO PNP		009			DANA	200011
Q13	201084	TRANS GERMAN PNP		2N1304		1	TI	2N1304
Q14	200043	TRANS SILICO NPN		2N3565			FAIRCHILD	2N3565
Q15	200035	TRANS SILICO NPN		014			DANA	200035
Q16	200022	TRANS SILICO PNP		012			DANA	200022
Q17	200043	TRANS SILICO NPN		2N3565			FAIRCHILD	2N3565
Q18	200043	TRANS SILICO NPN		2N3565			FAIRCHILD	2N3565
Q19	200022	TRANS SILICO PNP		012			DANA	200022
Q20	200035	TRANS SILICO NPN		014			DANA	200035
R01	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R02	010334	RES	SET				DANA	010334
R03	040062	RES	VARI	500 OHM	10%	1.5 W	CTS	110
R04	010334	RES	SET				DANA	010334

PARTS LIST

ASSEMBLY 402515 Isolator AC/DC Assembly, 220 A

REF. DESIG.	PART NO.	DESCRIPTION						
R05	030015	RES	WW	100 K	1%	10 W	C-F	M-100
R06	000513	RES	CARBON	51 K	5%	1/4 W1	OHMITE	RC07GF513J
R07	000514	RES	CARBON	510 K	5%	1/4 W1	OHMITE	RC07GF524J
R08	000513	RES	CARBON	51 K	5%	1/4 W1	OHMITE	RC07GF513J
R09	000154	RES	CARBON	150 K	5%	1/4 W1	OHMITE	RC07GF154J
R10	000205	RES	CARBON	2 M	5%	1/4 W1	OHMITE	RC07GF205J
R11	000202	RES	CARBON	2 K	5%	1/4 W1	OHMITE	RC07GF202J
R12	000912	RES	CARBON	9.1 K	5%	1/4 W1	OHMITE	RC07GF912J
R13	000103	RES	CARBON	10 K	5%	1/4 W1	OHMITE	RC07GF103J
R14	010059	RES	METAL	20 K	1%	1/4 W	ELECTRA	RN60D2002F
R15	000513	RES	CARBON	51 K	5%	1/4 W1	OHMITE	RC07GF513J
R16	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R17	000244	RES	CARBON	240 K	5%	1/4 W1	OHMITE	RC07GF244J
R18	010337	RES	METAL	10 MEG	1%		DALE	DCS1/2
R19	040099	RES	VARI	1 MEG	10%	1/4 W	BECKMAN	62PRIM
R20	000755	RES	CARBON	7.5 M	5%	1/4 W	OHMITE	RC07GF755J
R22	040100	RES	VARI	500 K			CTS	137.6818
R23	010337	RES	METAL	10 MEG	1%		DALE	DCS1/2
R24	000516	RES	CARBON	51 M	5%	1/4 W	OHMITE	RC07GF516J
R25	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R26	000184	RES	CARBON	180 K	5%	1/4 W	OHMITE	RC07GF184J
R27	000104	RES	CARBON	100 K	5%	1/4 W1	OHMITE	RC07GF104J
R28	000101	RES	CARBON	100 OHM	5%	1/4 W1	OHMITE	RC07GF101J
R29	000123	RES	CARBON	12 K	5%	1/4 W1	OHMITE	RC07GF123J
R30	000513	RES	CARBON	51 K	5%	1/4 W1	OHMITE	RC07GF513J
R31	040087	RES	VARI	10 K	10%	1/4 W	BECKMAN	62PR10K
R32	000432	RES	CARBON	4.3 K	5%	1/4 W1	OHMITE	RC07GF432J
R33	000301	RES	CARBON	300 OHM	5%	1/4 W	OHMITE	RC07GF301J
R34	000512	RES	CARBON	5.1 K	5%	1/4 W1	OHMITE	RC07GF512J
R35	000271	RES	CARBON	270 OHM	5%	1/4 W	OHMITE	RC07GF271J
R36	000202	RES	CARBON	2 K	5%	1/4 W1	OHMITE	RC07GF202J
R37	000513	RES	CARBON	51 K	5%	1/4 W1	OHMITE	RC07GF513J
R38	000912	RES	CARBON	9.1 K	5%	1/4 W1	OHMITE	RC07GF912J
R39	000153	RES	CARBON	15 K	5%	1/4 W1	OHMITE	RC07GF153J
R40	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R41	000432	RES	CARBON	4.3 K	5%	1/4 W1	OHMITE	RC07GF432J
R42	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R43	000820	RES	CARBON	82 OHM	5%	1/4 W	OHMITE	RC07GF820J

PARTS LIST

ASSEMBLY 402515 Isolator AC/DC Assembly, 220

A

REF. DESIG.	PART NO.	DESCRIPTION						
R44	000820	RES	CARBON	82 OHM	5%	1/4 W	OHMITE	RC07GF820J
R45	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R46	000101	RES	CARBON	100 OHM	5%	1/4 W1	OHMITE	RC07GF101J
R47	000103	RES	CARBON	10 K	5%	1/4 W1	OHMITE	RC07GF103J
R48	020241	RES	WW	10 K	.05%	1/8 W	JORDAN	J-11
R49	020204	RES	WW	1.1111 K	.05%	1/8 W	JORDAN	J-11
R50	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R51	000514	RES	CARBON	510 K	5%	1/4 W1	OHMITE	RC07GF514J
R52	000153	RES	CARBON	15 K	5%	1/4 W1	OHMITE	RC07GF153J
R53	040053	RES	VARI	5 K	10%	1.5 W	CTS	110
R54	001734	RES	FSV				DANA	001734
R55	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R56	000103	RES	CARBON	K	5%	1/4 W1	OHMITE	RC07GF103J
R57	00511	RES	CARBON	510 OHM	5%	1/4 W1	OHMITE	RC07GF511J
R58	000102	RES	CARBON	1 K	5%	1/4 W1	OHMITE	RC07GF102J
R59	000151	RES	CARBON	150 OHM	5%	1/4 W1	OHMITE	RC07GF151J

PARTS LIST

ASSEMBLY 402543 AC/DC Converter Assembly, 220 A

REF. DESIG.	PART NO.	DESCRIPTION							
CR01	211083	DIODE SILICO		018		1	DANA	211083	
CR02	211083	DIODE SILICO		018		1	DANA	211083	
CR03	211083	DIODE SILICO		018		1	DANA	211083	
CR04	220015	DIODE SILICO ZENER		1N967B			MOTOROLA	1N967B	
CR05	220015	DIODE SILICO ZENER		1N967B			MOTOROLA	1N967B	
CR06	211083	DIODE SILICO		018		1	DANA	211083	
CR07	211083	DIODE SILICO		018		1	DANA	211083	
CR08	211236	DIODE SILICO		007			DANA	211236	
CR09	211236	DIODE SILICO		007			DANA	211236	
CR10	221177	DIODE SILICO ZENER				1/4 W1	MOTOROLA	M.2.4A25	
CR11	221177	DIODE SILICO ZENER				1/4 W1	MOTOROLA	M.2.4A25	
C01	120007	CAP	MYLAR	.22 MFD	600 V	20%	FLEC CORE	210B1F224	
C02	120142	CAP	POLYS	FSV			DANA	120142	
C03	130054	CAP	CERAM	1-5 PFD		10%	AMPREX	C010KA/5E	
C04	120138	CAP	POLYS	20 PFD	630 V	5%	MIAL	611	
C05	120197	CAP	POLYS	2 PFD	1000 V	5%	DIEL	611	
C06	120161	CAP	POLYS	.047 MFD	63 V	2.5%	DIEL	N100	
C08	120162	CAP	POLYS	.0044 MFD	63 V	2.5%	MIAL	611.2D	
C09	120142	CAP	POLYS	FSV			DANA	120142	
C10	130055	CAP	CERAM	5-60 PFD		10%	AMPREX	C010MA/60E	
C11	120158	CAP	POLYS	390 PFD	63 V	5%	MIAL	611	
C12	130055	CAP	CERAM	5-60 PFD		10%	AMPREX	C010MA/60E	
C13	120034	CAP	POLYS	100 PFD	500 V	5%	CRL	CPR-100J	
C14	130054	CAP	CERAM	1-5 PFD		10%	AMPREX	C010KA/5E	
C15	120142	CAP	POLYS	FSV			DANA	120142	
C16	120163	CAP	POLYS	15 PFD	63 V	5%	DIEL	N100	
C17	111148	CAP	ELECT	100 MFD	25 V	20%1	SPRAGUE	TE1211	
C18	110047	CAP	ELECT	50 MFD	50 V	20%	DUCATI	50-50	
C19	110047	CAP	ELECT	50 MFD	50 V	20%	DUCATI	50-50	
C20	121393	CAP	MYLAR	.22 MFD	100 V	10%	CDE	WMF1P22	
C21	101145	CAP	CERAM	100 PFD	500 V	10%1	AEROVOX	SCD1X5F	
C22	100021	CAP	CERAM	82 PFD	500 V	10%	AEROVOX	TCD-N750	
C23	101145	CAP	CERAM	100 PFD	500 V	10%1	AEROVOX	SCD1X5F	
C24	110005	CAP	TANTA	10 MFD	50 V	10%1	SEMCOR	TSW1K-50-10	
C25	110022	CAP	TANTA	3.3 MFD	35 V	10%1	KEMET	K33C35K	
C26	110022	CAP	TANTA	3.3 MFD	35 V	10%1	KEMET	K33C35K	
K01	310035	RELAY	REED	SPST	24V		AZTEC	LIA24-S1	
K02	310035	RELAY	REED	SPST	24V		AZTEC	LIA24-S1	

PARTS LIST

ASSEMBLY 402543 AC/DC Converter Assembly, 220

A

REF. DESIG.	PART NO.	DESCRIPTION							
K03	310036	RELAY REED						ELEC-TROL	R2096-3
Q01	200085	TRANS			MPF103			MOTOROLA	MPF103
Q02	200022	TRANS SILICO PNP			012			DANA	200022
Q03	200037	TRANS SILICO NPN			2N3646			FAIRCHILD	2N3646
Q04	200037	TRANS SILICO NPN			2N3646			FAIRCHILD	2N3646
Q05	200037	TRANS SILICO NPN			2N3646			FAIRCHILD	2N3646
Q06	200011	TRANS SILICO PNP			009			DANA	200011
Q07	200090	TRANS SILICO NPN			SELECTED			FAIRCHILD	2N3565
Q08	200090	TRANS SILICO NPN			SELECTED			FAIRCHILD	2N3565
Q09	200022	TRANS SILICO PNP			012			DANA	200022
Q10	200043	TRANS SILICO NPN			2N3565			FAIRCHILD	2N3565
Q11	200068	TRANS			2N4250			FAIRCHILD	2N4250
Q12	200011	TRANS SILCO PNP			009			DANA	200011
Q13	200035	TRANS SILICO NPN			014			DANA	200035
R01	010341	RES METAL	SET					DANA	010341
R02	010341	RES METAL	SET					DANA	010341
R03	040104	RES VARI	50 K					BECKMAN	62P
R04	000273	RES CARBON	27 K		5%	1/4 W1		OHMITE	RC07GF273J
R05	040110	RES VARI	100 OHM					BBECKMAN	62PR100
R06	010341	RES METAL	SET					DANA	010341
R07	040123	RES VARI	1K		10%	1/4 W		BECKMAN	62PR500
R08	010341	RES METAL	SET					DANA	010341
R09	040046	RES VARI	20 K		10%	1/4 W		BECKMAN	62PR20K
R10	010341	RES METAL	SET					DANA	010341
R11	000104	RES CARBON	100 K		5%	1/4 W1		OHMITE	RC07GF104J
R12	000332	RES CARBON	3.3 K		5%	1/4 W1		OHMITE	RC07GF332J
R13	010341	RES METAL	SET					DANA	010341
R14	000102	RES CARBON	1 K		5%	1/4 W1		OHMITE	RC07GF102J
R15	000102	RES CARBON	1 K		5%	1/4 W1		OHMITE	RC07GF102J
R16	000102	RES CARBON	1 K		5%	1/4 W1		OHMITE	RC07GF102J
R17	000104	RES CARBON	100 K		5%	1/4 W1		OHMITE	RC07GF104J
R18	000752	RES CARBON	7.5 K		5%	1/4 W1		OHMITE	RC07GF752J
R19	000106	RES CARBON	10 M		5%	1/4 W1		OHMITE	RC07GF106J
R20	000104	RES CARBON	100 K		5%	1/4 W1		OHMITE	RC07GF104J
R21	000104	RES CARBON	100 K		5%	1/4 W1		OHMITE	RC07GF104J
R22	000203	RES CARBON	20 K		5%	1/4 W1		OHMITE	RC07GF203J
R23	010341	RES METAL	SET					DANA	010341
R24	010341	RES METAL	SET					DANA	010341

PARTS LIST

ASSEMBLY 402543 AC/DC Converter Assembly, 220 A

REF. DESIG.	PART NO.	DESCRIPTION							
R25	000106	RES	CARBON	10	M	5%	1/4 W1	OHMITE	RC07GF106J
R26	000332	RES	CARBON	3.3	K	5%	1/4 W1	OHMITE	RC07GF332J
R27	000512	RES	CARBON	5.1	K	5%	1/4 W1	OHMITE	RC07GF512J
R28	000751	RES	CARBON	750	OHM	5%	1/4 W1	OHMITE	RC07GF751J
R29	000103	RES	CARBON	10	K	5%	1/4 W1	OHMITE	RC07GF103J
R30	001712	RES	CARBON	750	OHM	5%	1/2 W	OHMITE	RC20GF751J
R31	001712	RES	CARBON	750	OHM	5%	1/2 W	OHMITE	RC20GF751J
R32	000332	RES	CARBON	3.3	K	5%	1/4 W1	OHMITE	RC07GF332J
R33	000101	RES	CARBON	100	OHM	5%	1/4 W1	OHMITE	RC07GF101J
R34	000101	RES	CARBON	100	OHM	5%	1/4 W1	OHMITE	RC07GF101J
R35	000332	RES	CARBON	3.3	K	5%	1/4 W1	OHMITE	RC07GF332J
R36	000101	RES	CARBON	100	OHM	5%	1/4 W1	OHMITE	RC07GF101J
R37	000331	RES	CARBON	330	OHM	5%	1/4 W1	OHMITE	RC07GF331J
R38	000331	RES	CARBON	330	OHM	5%	1/4 W1	OHMITE	RC07GF331J
R39	010341	RES	METAL	SET				DANA	010341
R40	010060	RES	METAL	10	K	1%	1/4 W	ELECTRA	RN60D1002F
R41	010341	RES	METAL	SET				DANA	010341
R42	010060	RES	METAL	10	K	1%	1/4 W	ELECTRA	RN60D1002F
R43	000201	RES	CARBON	200	OHM	5%	1/4 W1	OHMITE	RC07GF201J
R44	000105	RES	CARBON	1	M	5%	1/4 W1	OHMITE	RC07GF105J

SECTION 7

BCD OUTPUT OPTION

Model 4432

7.0 GENERAL

7.1. The Dana Model 4432 is a standard Model 4430 DMM with the added capability of providing a BCD output of function, range, and display data for a printer or other digital recording device. The Model 4432 is compatible with all of the accessories available for the 4400 series DMM's, such as the accessory modules 210, 212, 220 and 230.

7.2. The 4432 produces an 8421 positive true, voltage level output to a 50-pin connector at the rear of the instrument. The voltage levels produce a binary code for use by the printer and indicate the most recent measurement by the DMM. The BCD code, logic levels and pin connectors are compatible with commonly available printers such as the HP-562A and the HP-5050A.

7.3. Physically, the output circuitry is located on a printed circuit board (designated Buffer) mounted directly above the readout section of the DMM. Interconnecting cables from the readout circuitry to the buffer and from the buffer to the output connector are shown in figure 7.7. The output data, with the exception of range, is generated by transistor switches (see figure 7.1). The range data is generated by a transistor-driven diode matrix. All outputs are approximately +7 volts through 5.6K ohms when true and no greater than +1 volt when false. Voltage for the output option is taken internally from the DMM power supply.

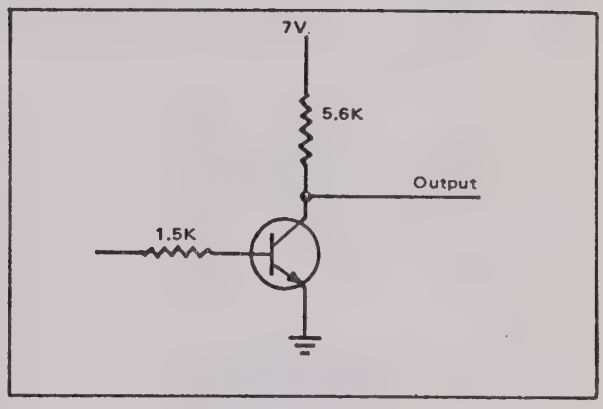


Figure 7.1. Typical Output Circuit

7.4. Since the BCD output circuitry is connected directly to the voltmeter measuring circuits, either the recording device should be isolated from ground or the input signal should be floating to prevent measurement errors due to ground loops.

7.5 OPERATION

7.6. The function and range are selected at the front panel of the DMM (auto range is not used with the BCD output). The BCD data is held continuously until an internal or external command

indicates a new reading.

7.7 EXTERNAL COMMAND

7.8. By placing the DMM in Hold, the DMM takes a new reading only when an external command pulse is received through pin 45 on the BCD output connector. The external command pulse is a +7 volt pulse with a duration greater than .02 milliseconds and less than 5 milliseconds. Rise time must be less than 1 microsecond (see figure 7.2).

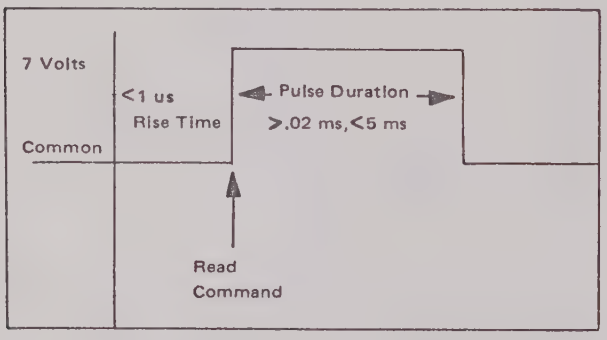


Figure 7.2. External Command

7.9 DELAYS

7.10. Since no time delays are provided in the instrument, delays for settling time must be provided externally to achieve required accuracy levels (see Timing Information, Paragraph 7.26).

7.11 PRINT COMMAND OUTPUT

7.12. The print command is a positive pulse appearing at pin 48 of J11 and generated within the DMM during the read cycle. At the completion of the cycle, the pulse drops to .1 volt, commanding the printer to record all the data at the output connector J11. The print command pulse is +7 volts with a duration of 18 milliseconds or less (the duration of the pulse is dependent on the length of the DMM read cycle). The pulse drops to .1 volt in less than 5 microseconds to command the printer (see figure 7.3).

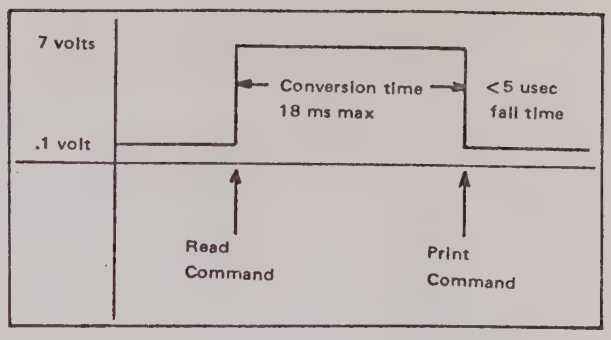


Figure 7.3. Print Command

7.13 BCD CODING

7.14. The coding of DMM digital output is positive true 8421. In the tables below, the 1's represent true or +7 volts and 0's represent false or less than 1 volt.

Digits	8	4	2	1
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

Function	8	4	2	1
AC	0	0	1	1
Ohms	0	0	0	1
+ Polarity	1	0	1	0
- Polarity	1	0	1	1

Range	8	4	2	1
10,000	0	0	0	0
1,000	0	0	0	1
100	0	0	1	0
10	0	0	1	1
1	0	1	0	0
.1	0	1	0	1

7.15 PIN ASSIGNMENTS

7.16. The locations for the BCD output are shown below. All lines are referenced to pin 24 (common).

7.17 OUTPUT CONNECTOR J11

PIN		PIN	
1	Range (1)	26	Range (4)
2	Range (2)	27	Range (8)
3	Function (1)	28	Function (4)
4	Function (2)	29	Function (8)
5	Ones (1)	30	Ones (4)
6	Ones (2)	31	Ones (8)
7	Tens (1)	32	Tens (4)
8	Tens (2)	33	Tens (8)
9	Hundreds (1)	34	Hundreds (4)
10	Hundreds (2)	35	Hundreds (8)
11	Thousands (1)	36	Thousands (4)
12	Thousands (2)	37	Thousands
13	Ten Thousands (1)	38	Ten Thousands (4)
14	Ten Thousands (2)	39	Ten Thousands (8)
15		40	
16		41	
17	Overload (false during overload condition)	42	
18		43	
19		44	
20		45	Read Command Input
21		46	
22		47	
23		48	Print Command Signal
24	Common, "o" reference	49	
25	+7 volts, "1" reference	50	

MATING CONNECTOR: 50 Pin amphenol blue ribbon 57-30500.

7.18 DANA 4432 OUTPUT/PRINTER INTERFACE.

4432 Option	Logic Type	HP562A Option	HP5050A Option	CMC41.0A Option
(4432)	1-2-4-8 +7V=true	22	01	4a*

*Special Cable Required.

7.19 HEWLETT PACKARD 562A AND 5050A

Interfacing. The Dana 4432 interfaces directly with the Hewlett-Packard 562A or 5050A printers, using the standard HP interconnecting cable. This cable is a 50-wire, one-to-one cable connecting two 50-pin Amphenol blue ribbon connectors (Amphenol No. 57-30500.) The only additional interfacing is the connection of two lines from the read command source. These lines are brought into the cable and connected to pins 24 and 45. (Refer to figure 7.4.)

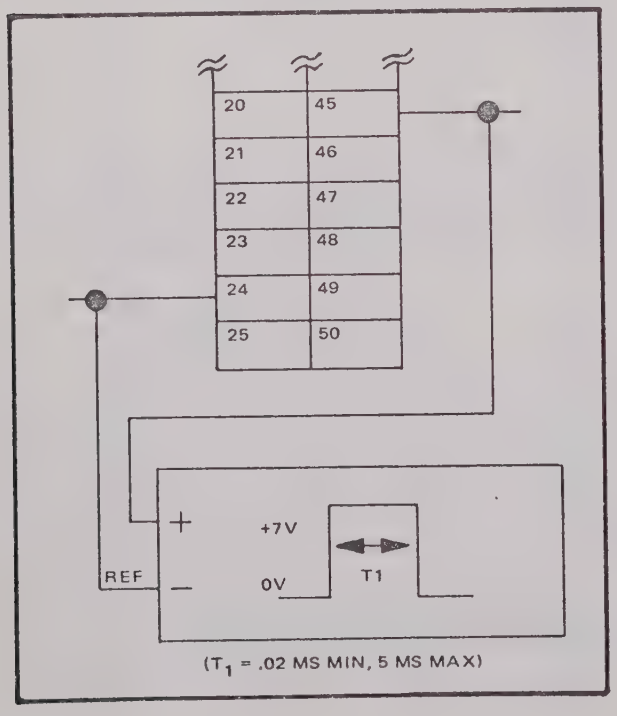


Figure 7.4. Read Command

7.20 An external supply or an npn switch between pins 24 and 25 can be used (refer to figure 7.5).

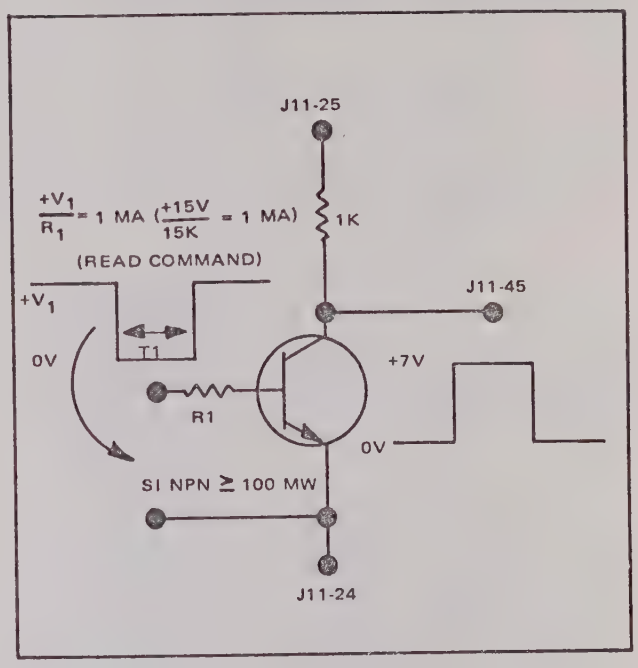


Figure 7.5. Read Command Switch

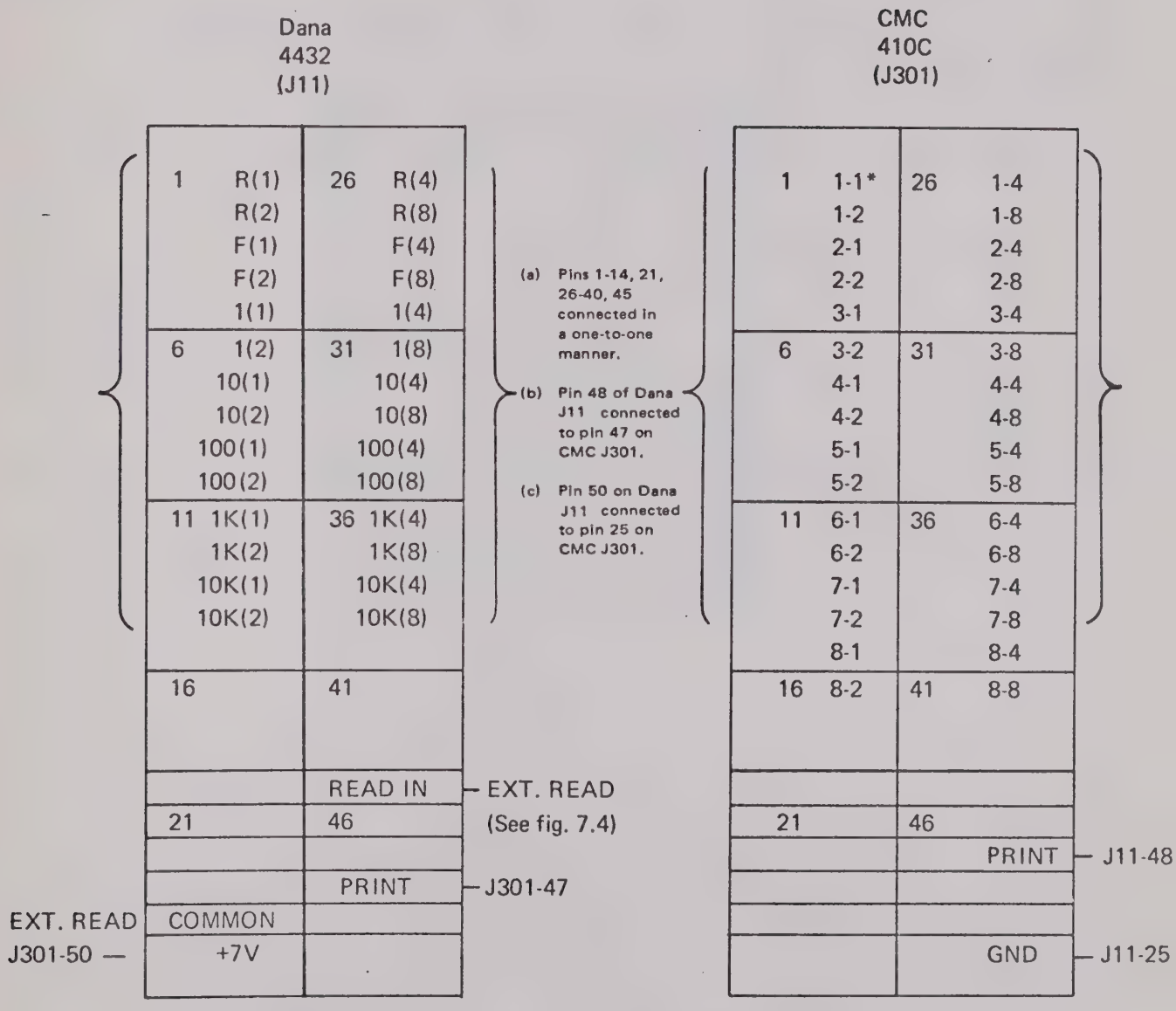
7.21 DATA PRESENTATION. The 4432 output will appear as follows:

Column 1 - decimal number indicating range
Column 2 - decimal number indicating function/polarity
Column 3 - Most significant digit (overrange bit)
Column 4 - Second most significant digit
Column 5 - Third most significant digit
Column 6 - Fourth most significant digit
Column 7 - Least significant digit

NOTE: The read command line of the 4432 (pin 45) appears on a data line for column 10 on the HP-5050 printer. Since only seven columns are required for the 4432, column 10 is not used. If the printer has a column 10, operation of the printer will not be affected, since the command level is zero at the time of the print pulse.

7.22 CMC 410A

7.23 Interfacing. A slight modification from a standard "one-to-one" cable is required to interface the 4432 with the CMC 410A printer (refer to figure 7.6).



* 1-1 means printer column 1, 2^0 = 1 bit
3-4 means printer column 3, 2^2 = 4 bit

Figure 7.6. 4432/CMC 410A Interconnecting Cable

7.24 The 410A interconnecting cable will develope a "negative-level," positive true data interface. (Refer to CMC 410A manual, option 4a.) An external read command can be applied to the 4432, as shown in figures 7.4 and 7.5.

DC SETTLING TIME WITH RESPECT TO SOURCE RESISTANCE - (4400 Series)	
Source Resistance	To .01%
0	500 ms
10K	670 ms
20K	790 ms
30K	920 ms
50K	1.1 sec
100K	1.7 sec
200K	2.7 sec
300K	3.7 sec
500K	4.4 sec
1 meg	10.0 sec

7.25 Data and Presentation. Same as HP562A/5050A. As the 4432 cannot drive the printer decimal lines directly, the range information will appear on the first column.

7.26 TIMING INFORMATION

Maximum digitizing time - 18 milliseconds
Full scale step function
settling time to .01% - dc - .5 sec
ac - 2 sec
ohms -
1K - 1 meg - 1 sec
10 meg - 10 sec
Recycle Time 25 milliseconds
Maximum Read Rate 22 readings/sec

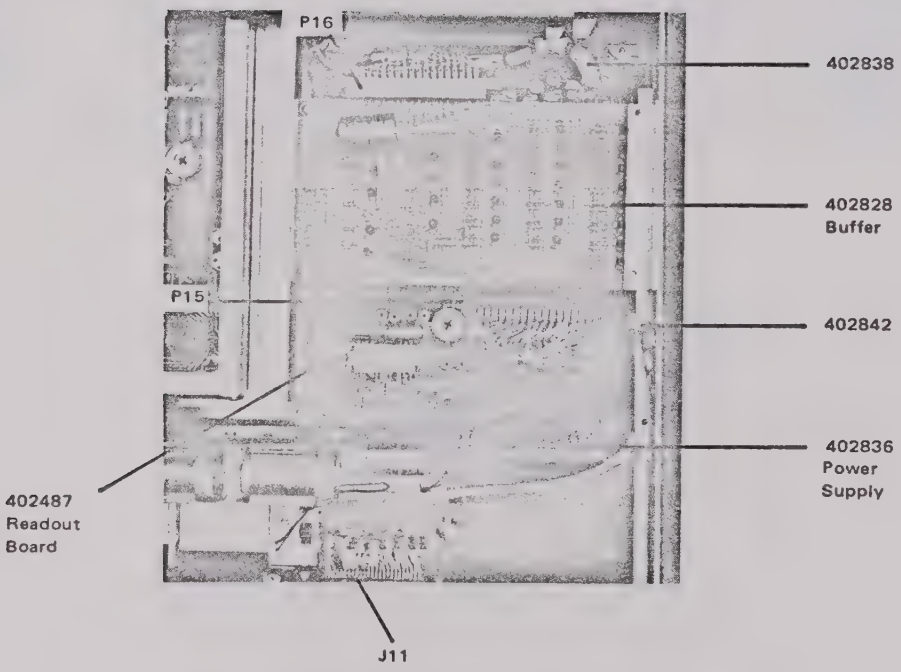
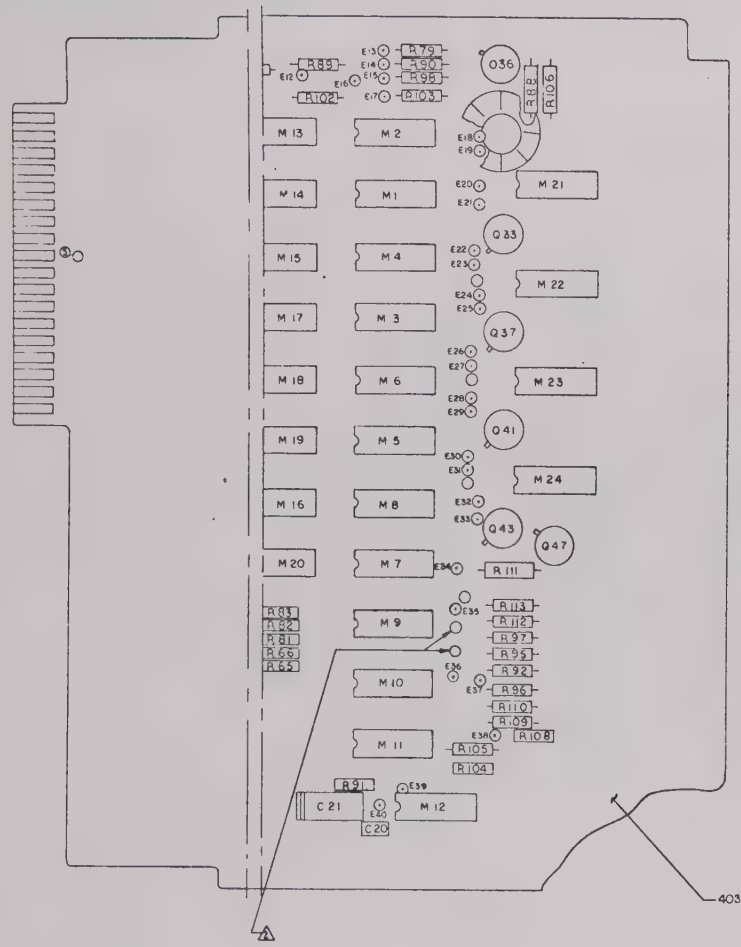
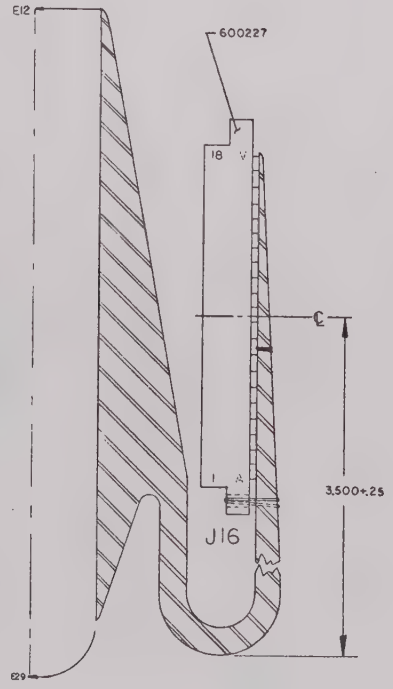


Figure 7.7 (BCD Output Interconnection Diagram)

DRAWINGS - OUTPUT OPTION 4432

Input Cable Assembly	402838
Output Buffer Assembly	402828
Output Buffer Schematic	430804
Cable Harness	402842
Power Supply	402836





FROM	TO	CONDUCTOR TYPE, COLOR	P/N	WIRE LGTH	CIRCUIT LOCATION
E-12	J18-S	8-1	524918		P1-M
E-13	J18-M	8-2	524928		P1 V
E-14	J18-P	8-3	524939		P1 18
E-15	J18-R	8-9	524898		P1 17
E-16	J18-10	8-1-0	524910		P1 10
E-17	J18-V	8-1-1	524911		P1 U
E-18	J18-B	8-1-2	524912		M2 14
E-19	J18-A	8-1-3	524913		M2 8
E-20	J18-S	8-1-4	524914		M1 14
E-21	J18-C	8-1-5	524915		M1 8
E-22	J18-2	8-1-6	524916		M4 14
E-23	J18-1	8-1-7	524917		M4 8
E-24	J18-3	8-1-8	524918		M3 14
E-25	J18-A	8-2-0	524920		M3 8
E-26	J18-8	8-2-1	524921		M5 14
E-27	J18-E	8-2-2	524922		M6 8
E-28	J18-F	8-2-3	524923		M5 14
E-29	J18-9	8-2-4	524924		M5 8
E-30	J18-13	8-2-5	524925		M8 14
E-31	J18-6	8-2-6	524926		M8 8
E-32	J18-D	8-2-7	524927		M7 14
E-33	J18-7	8-2-8	524928		M7 8
E-34	J18-M	8-3-0	524930		M9 14
E-35	J18-J	8-3-1	524931		M9 8
E-36	J18-U	8-3-2	524932		P1 L
E-37	J18-11	8-3-4	524934		P1 H
E38	J18 T	8-3-5	524935		M10 9
E-39	J18-12	8-3-8	524936		M12 14
E-40	J18-14	8-1	524919		M12 3

QTY REQD	ASS PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT NO	SPECIFICATION DWG OR VENDOR PN	ITEM NO
AR	SEE WIRELIST	WIRE 24 GA TEFLON COATED			4
AR	920026	SOLDER-WIRE .0326 3/37 RESIN CORE			3
1	600227	CONNECTOR, CINCH		251-18-30-160	2
1	403051	ASSEMBLY - READOUT BOARD			1

2. TIE HARNESS SECURELY TO BOARD AT THESE EXISTING HOLES WITH LACING CORD

1. COMPONENTS SHOWN ARE FOR REF. LOCATION WIRING HARNESS ONLY.

NOTES UNLESS OTHERWISE SPECIFIED

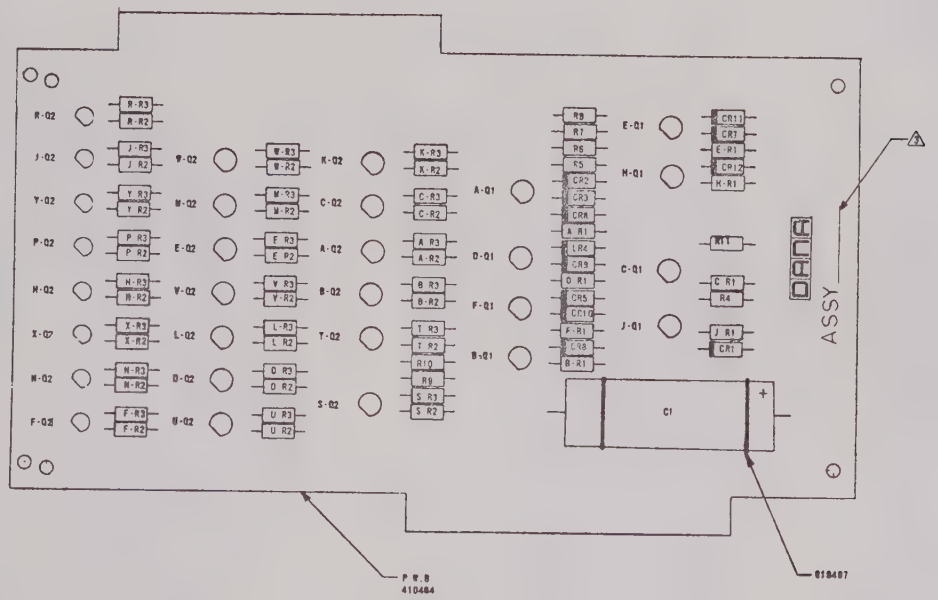
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSEMBLY

READOUT BOARD-INPUTCABLE

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	402838	B

SCALE 2/1 SHEET 1 OF 1



4. FOR PARTS LIST SEE SHEET: 3

⚠1 RUBBER STAMP TOP ASSY NO. AND LATEST REV. LETTER IN APPROXIMATE AREAS SHOWN (NEARSIDE).

2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS

1. FOR SCHEMATIC SEE: 430804

NOTES UNLESS OTHERWISE SPECIFIED

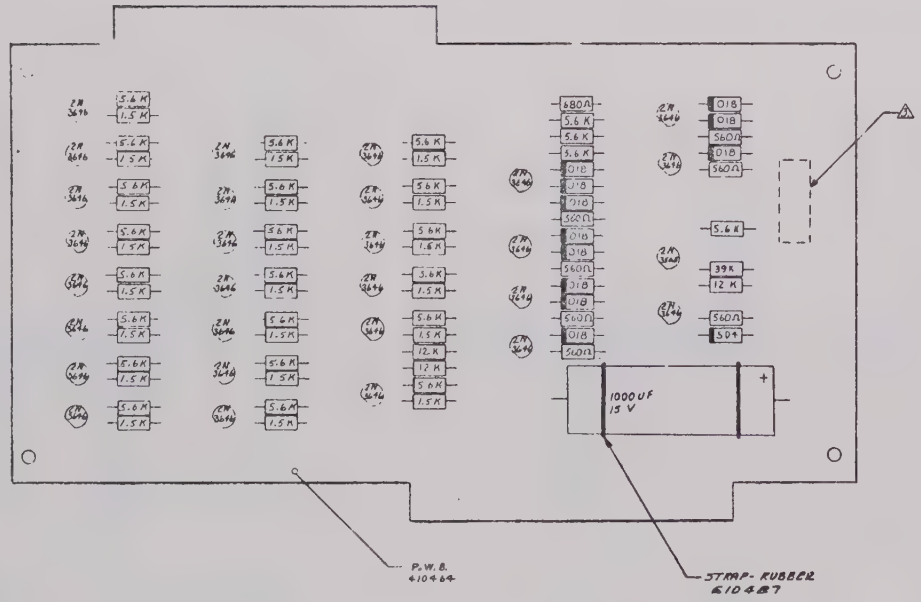
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

ASSY - OUTPUT BUFFER

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	402828	B

SCALE 2:1 SHEET 1 OF 3

SHEET 3 "C" SIZE



4. FOR PARTS LIST SEE SHEET 3

⚠ RUBBER STAMP TOP ASSY NO AND LATEST REV LETTER IN APPROXIMATE AREAS SHOWN (NEARSIDE).

2. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM TO DANA WORKMANSHIP STANDARDS

1. FOR SCHEMATIC SEE: 430804

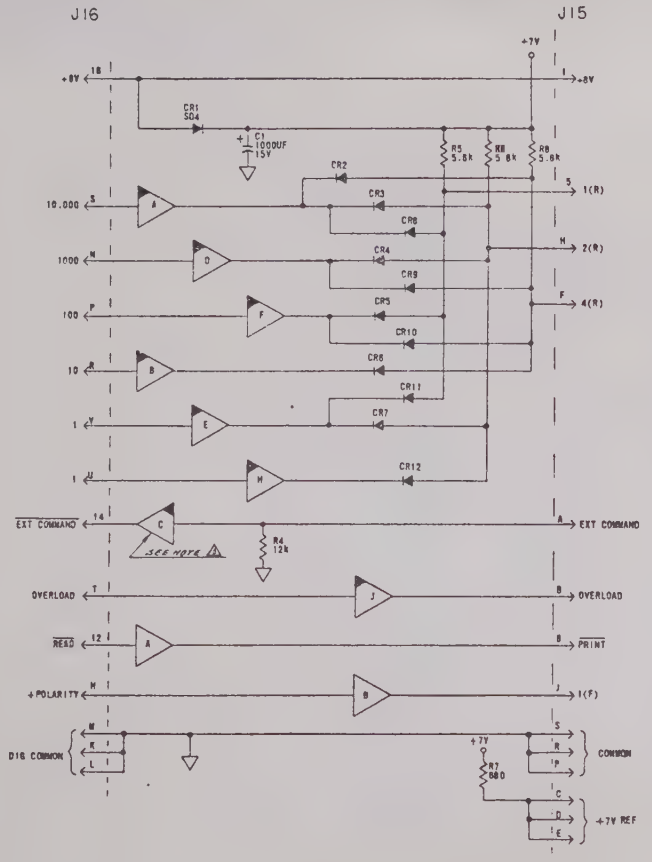
NOTES UNLESS OTHERWISE SPECIFIED

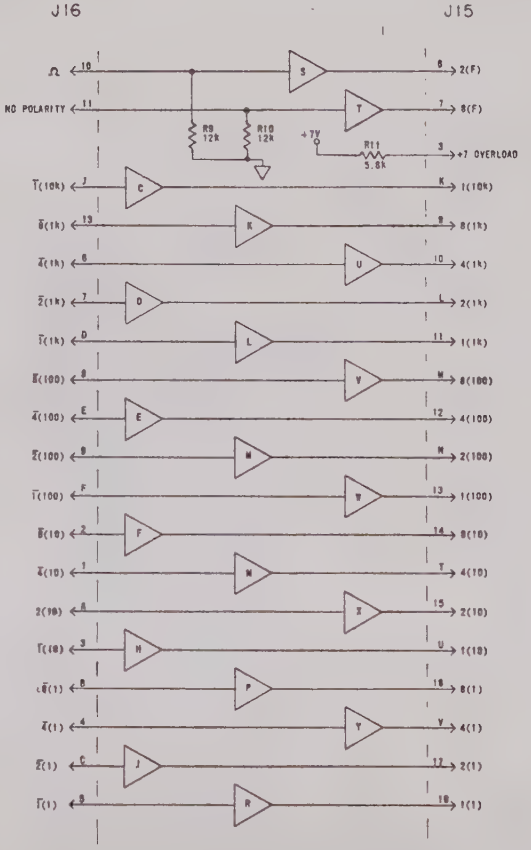
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

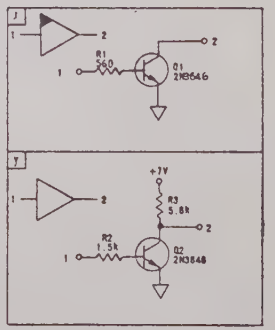
ASSY - OUTPUT BUFFER

SIZE	CODE IDENT NO	DWG NO	
D	21793	402828	A

SCALE 2:1 SHEET 2







6. THIS SYMBOL ▽ INDICATES DIGITAL COMMON
5. AS AN EXCEPTION MODULE ◁ WILL HAVE R9 39k & Q1 2N3565
4. HIGHEST REFERENCE DESIGNATOR USED ARE C1, CR12, R10, Q2
3. ALL RESISTORS ARE CARBON 1/4W 5%
2. ALL TRANSISTORS ARE 2N3646
1. ALL DIODE ARE D18

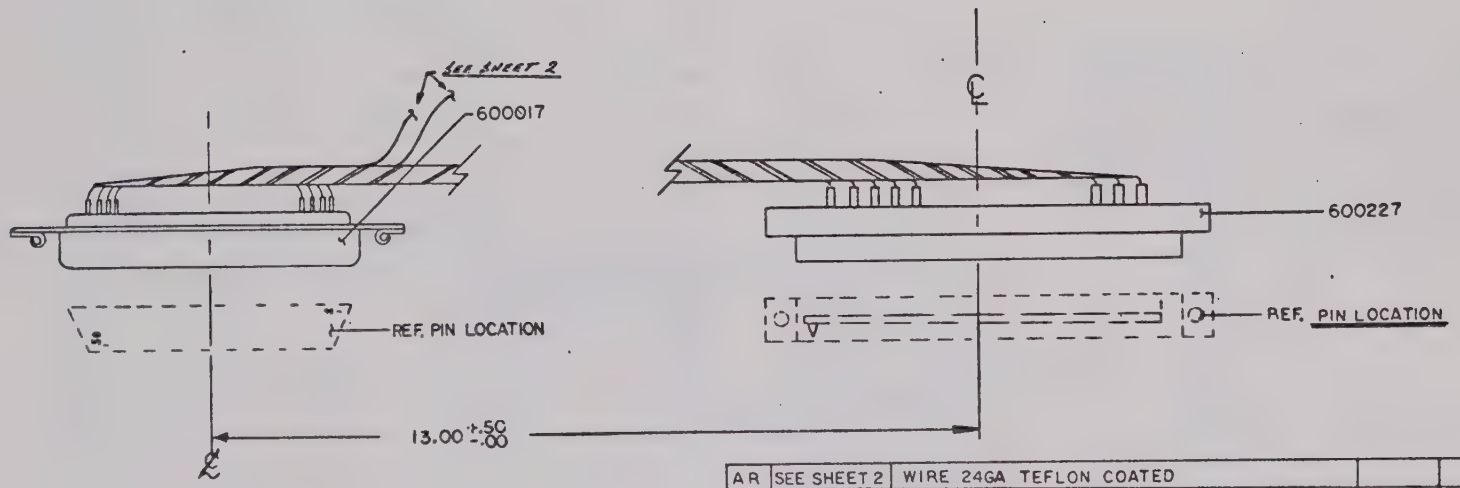
NOTES UNLESS OTHERWISE SPECIFIED

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC - OUTPUT BUFFER

SIZE	CODE IDENT NO	DWG NO.	REV
D	21793	430804	

SCALE NON- SHEET 1 OF 1



QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.
AR	SEE SHEET 2	WIRE 24GA TEFLON COATED			4
AR	920026	SOLDER-WIRE .03263/37 RESIN CORE			3
1	600227	CONNECTOR, CINCH		251-18-30-160	2
1	600017	CONNECTOR, AMPHENOL 57 SERIES MICRO RIBBON			1

LIST OF MATERIAL OR PARTS LIST

NEXT DWG	USED ON	NEXT ASSY	FINAL ASSY
402836	4432	1	1
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS: .X .030, .XX .020, .XXX .010 | ANGLES: 0° 30' | HOLE DIAMETERS: +.004 −.001

MATERIAL

FINISH

DRAWN	P. Hanlon	5/6/68
CHECK	P. Timmerman	5/14/68
DESIGN	P. Timmerman	5/14/68
MECH ENGR	[illegible]	5-20-68
PROJ ENGR	[illegible]	5/14

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

CABLE HARNESS BUFFER UNIT

SIZE	CODE IDENT NO.	DWG NO.	REV
C	21793	402842	

SCALE NONE | SHEET 1 OF 2

3. SEE FOR WIRING LIST SHEET 2.
2. SCHEMATIC REF 430804
1. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS

NOTES: UNLESS OTHERWISE SPECIFIED

FROM	TO	CONDUCTOR TYPE, COLOR	P/N	WIRE LGTH	NOTES
J14-10	J15-M	9-1-5	524915		
J14-1	J15-5	9-1	524918		
J14-2	J15-H	9-2	524929		
J18-3	J15-J	9-3	524939		
J14-4	J15-6	9-9	524938		
J14-5	J15-19	9-1-0	524910		
J14-6	J15-17	9-1-1	524911		
J14-7	J15-U	9-1-2	524912		
J14-8	J15-15	9-1-3	524913		
J14-9	J15-13	9-1-4	524914		
J14-11	J15-11	9-1-6	524916		
J14-12	J15-L	9-1-7	524917		
J14-13	J15-K	9-1-8	524918		
J14-14	J15-R	9-2-0	524920		
J14-17	J15-B	9-2-1	524921		
J14-24	J15-S	9-2-2	524922		
J14-25	J15-E	9-2-3	524923		
J14-26	J15-F	9-2-4	524924		
J14-27	J15-P	9-2-5	524925		
J14-23	J15-P	9-2-6	524926		
J14-29	J15-7	9-2-7	524927		

FROM	TO	CONDUCTOR TYPE, COLOR	P/N	WIRE LGTH	NOTES
J14-30	J15-V	9-2-8	524928		
J14-31	J15-18	9-3-0	524930		
J14-32	J15-T	9-3-1	524931		
J14-33	J15-14	9-3-2	524932		
J14-34	J15-12	9-3-4	524934		
J14-35	J15-M	9-3-5	524935		
J14-36	J15-10	9-3-6	524936		
J14-37	J15-9	9-1	524919		
J14-38	J15-R	9-2	524929		
J14-39	J15-R	9-3	524939		
J14-45	J15-A	9-9	524909		
J14-46	J15-8	9-1-0	524910		
J18-3	J15-9	9-2-0	524920		
J15-S	E11 (SEE NOTE)	9-1	524922		COMMON
J15-1	E12 (SEE NOTE)	9-0-9	524909		+8V

1. SEE 402836 FOR WIRE LOCATION. (E11 & E12)

NOTES: UNLESS OTHERWISE SPECIFIED

+.2035	4432	1	1
NEXT DWG	USED ON	NEXT DWG	FINAL ASSY
APPLICATION		QTY REQD	

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON:
DECIMALS .X .030 .XX .020 .XXX .010 | ANGLES 0° 30' FORMED 1 0° | HOLE DIAMETERS +.004 .001

MATERIAL

FINISH

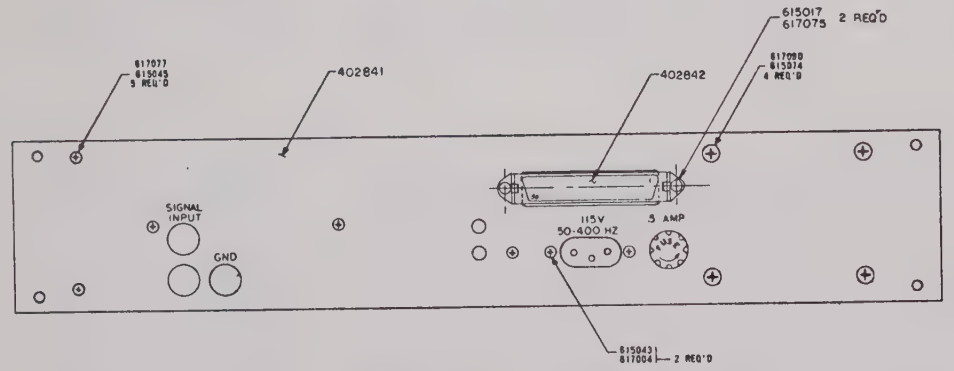
DRAWN	P Hasham	4-16-68
CHECK		
DESIGN	[illegible]	4-16-68
MECH ENGR	[illegible]	4-16-68
PROJ ENGR	[illegible]	4/4

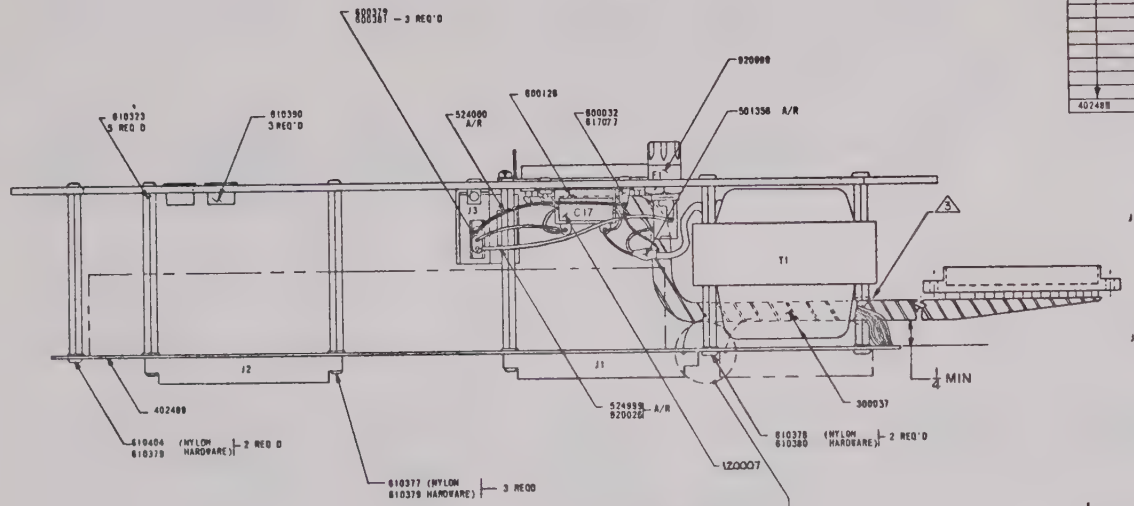
DANA LABORATORIES INC.
IRVINE, CALIFORNIA

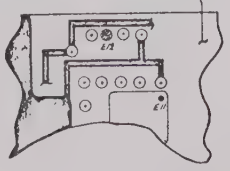
CABLE HARNESS
BUFFER UNIT

SIZE	CODE IDENT NO.	DWG NO.	REV
C	21793	402842	

SCALE NONE | SHEET 2 OF 2



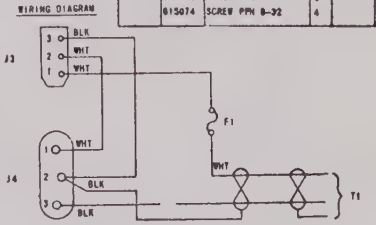




VIEW ONLY USED FOR WIRING PURPOSE. (SEE SHEET 2 OF 402842)

WIRE LIST			
402489	E#	COLOR	T1
	2	GY	
	9	BLU	
	3	YIO	
	4	BRN	
	8	GRN	
	6	ORG	
	7	YEL	
	10	BLK	
	5	RED	
402488	1	WHT	T1

WIRING DIAGRAM



REF DES OR ITEM	P/N	DESCRIPTION	QTY
C17	120007	CAP 22UF/600V	1
	300037	INSR PWR	1
	402488	PCB ASSY PWR SUP	1
	402841	PANEL REAR ASSY	1
	402842	CABLE HARNESS	1
	430877	SCHEMATIC PWR SUP	A/R
	501358	SHRINK TUBING	A/R
	524000	WIRE-0 COLOR	A/R
	524888	WIRE-8 COLOR	A/R
	609032	LUG SOLDER	1
	680128	RECP AC PCB	1
	800379	CONN RECP	1
	800381	PIN RECP	3
	810323	STOF HD 8-32 1/4 HEX X 3 LG AL	5
			2
	810377	SCREW-NYLON 4-40	3
	810376	SCREW-NYLON 8-32	2
	810379	WASH-NYLON NO 4	5
	810380	WASH-NYLON NO 8	2
	810390	PLUG-HOLE	3
	810404	SCREW-NYLON 4-40	2
	615017	SCREW 2-56 X 3/16	2
	615043	SCREW PPH 4-40	2
	615045	SCREW PPH	5
	615074	SCREW PPH 8-32	4

REF DES OR ITEM	P/N	DESCRIPTION	QTY
	617004	HEX NUT 4-40	2
	617075	WASH INT LOCK 2	2
	617077	WASH INT LOCK 4	8
	617008	WASH INT LOCK 8	4
	820035	SOLDER-WIRE	A/R
	820088	FUSEHOLD	1

⚠ SECURE CABLE TO SPACER WITH LACING CORD

2. SCHEMATIC REF. NO 430877

1. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS.

NOTE. UNLESS OTHERWISE SPECIFIED

QTY REQD	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION OR VENDOR P/N	ITEM NO.

LIST OF MATERIAL OR PARTS LIST

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

POWER SUPPLY ASSY
FULL RACK

SIZE	CODE IDENT NO	DWG NO	REV
D	21793	402836	D

SCALE 1/1 WT SHEET 1 OF 1

PARTS LIST

ASSEMBLY 402828 Assy-Output Buffer, 4432 A

REF. DESIG.	PART NO.	DESCRIPTION			
CR01	210004	DIODE SILICO	SD4	DIODES IN SD4	
CR02	211083	DIODE SILICO	018	1 DANA	211083
CR03	211083	DIODE SILICO	018	1 DANA	211083
CR04	211083	DIODE SILICO	018	1 DANA	211083
CR05	211083	DIODE SILICO	018	1 DANA	211083
CR06	211083	DIODE SILICO	018	1 DANA	211083
CR07	211083	DIODE SILICO	018	1 DANA	211083
CR08	211083	DIODE SILICO	018	1 DANA	211083
CR09	211083	DIODE SILICO	018	1 DANA	211083
CR10	211083	DIODE SILICO	018	1 DANA	211083
CR11	211083	DIODE SILICO	018	1 DANA	211083
CR12	211083	DIODE SILICO	018	1 DANA	211083
C01	110077	CAP ELECT 1000 MFD 15 V		AMPEREX	C437PR/E1000
A-Q01	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
B-Q01	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
C-Q01	200043	TRANS SILICO NPN	2N3565	FAIRCHILD	2N3565
D-Q01	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
E-Q01	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
F-Q01	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
H-Q01	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
J-Q01	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
A-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
B-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
C-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
D-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
F-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
F-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
H-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
J-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
K-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
L-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
M-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
N-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
P-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
R-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
S-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
T-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646
U-Q02	200037	TRANS SILICO NPN	2N3646	FAIRCHILD	2N3646

PARTS LIST

ASSEMBLY 402828 Assy-Output Buffer, 4432 A

REF. DESIG.	PART NO.	DESCRIPTION							
V-Q02	200037	TRANS SILICO NPN			2N3646			FAIRCHILD	2N3646
W-Q02	200037	TRANS SILICO NPN			2N3646			FAIRCHILD	2N3646
X-Q02	200037	TRANS SILICO NPN			2N3646			FAIRCHILD	2N3646
Y-Q02	200037	TRANS SILICO NPN			2N3646			FAIRCHILD	2N3646
A-R01	000561	RES	CARBON	560 OHM	5%	1/4 W1		OHMITE	RC07GF561J
B-R01	000561	RES	CARBON	560 OHM	5%	1/4 W1		OHMITE	RC07GF561J
C-R01	000393	RES	CARBON	39 K	5%	1/4 W		OHMITE	RC07GF393J
D-R01	000561	RES	CARBON	560 OHM	5%	1/4 W1		OHMITE	RC07GF561J
E-R01	000561	RES	CARBON	560 OHM	5%	1/4 W1		OHMITE	RC07GF561J
F-R01	000561	RES	CARBON	560 OHM	5%	1/4 W1		OHMITE	RC07GF561J
H-R01	000561	RES	CARBON	560 OHM	5%	1/4 W1		OHMITE	RC07GF561J
J-R01	000561	RES	CARBON	560 OHM	5%	1/4 W1		OHMITE	RC07GF561J
A-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
B-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
C-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
D-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
E-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
F-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
H-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
J-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
K-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
L-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
M-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
N-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
P-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
R-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
S-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
T-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
U-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
V-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
W-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
X-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
Y-R02	000152	RES	CARBON	1.5 K	5%	1/4 W1		OHMITE	RC07GF152J
A-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1		OHMITE	RC07GF562J
B-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1		OHMITE	RC07GF562J
C-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1		OHMITE	RC07GF562J
D-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1		OHMITE	RC07GF562J
E-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1		OHMITE	RC07GF562J

PARTS LIST

ASSEMBLY 402828 Assy-Output Buffer, 4432 A

REF. DESIG.	PART NO.	DESCRIPTION						
F-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
H-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
J-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
K-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
L-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
M-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
N-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
P-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
R-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
S-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
T-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
U-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
V-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
W-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
X-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
Y-R03	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
R04	000123	RES	CARBON	12 K	5%	1/4 W1	OHMITE	RC07GF123J
R05	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
R06	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
R07	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J
R08	000681	RES	CARBON	680 OHM	5%	1/4 W1	OHMITE	RC07GF681J
R09	000123	RES	CARBON	12 K	5%	1/4 W1	OHMITE	RC07GF123J
R10	000123	RES	CARBON	12 K	5%	1/4 W1	OHMITE	RC07GF123J
R11	000562	RES	CARBON	5.6 K	5%	1/4 W1	OHMITE	RC07GF562J

www.manualsplus.com
1014008